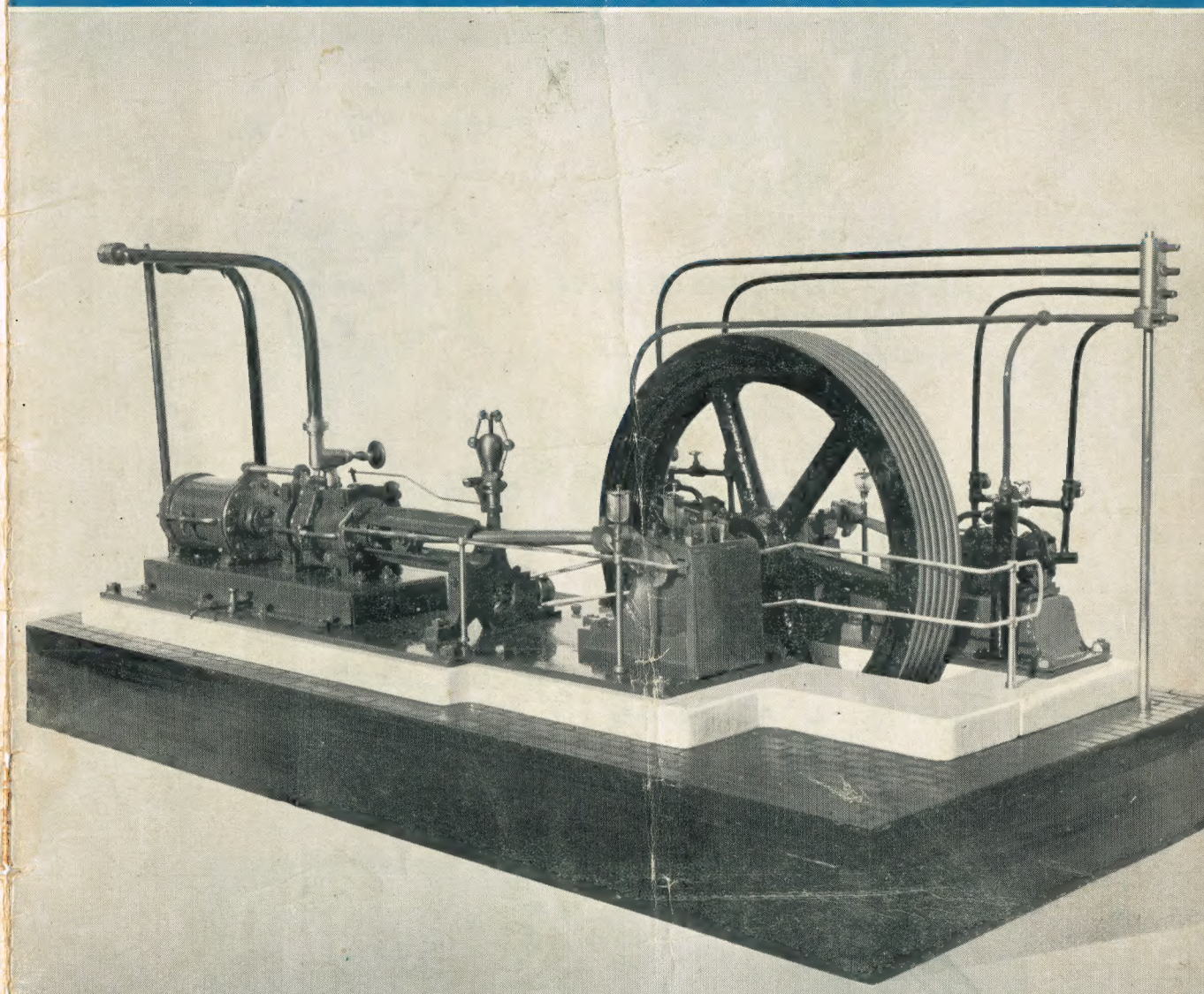
THE MODEL ENGINEER



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L.B.S.C.'s "NETTA" ● DOUBLE TANGYE-TYPE MILL ENGINE

APRIL 1st 1954
Vol. 110 No. 2758

9D

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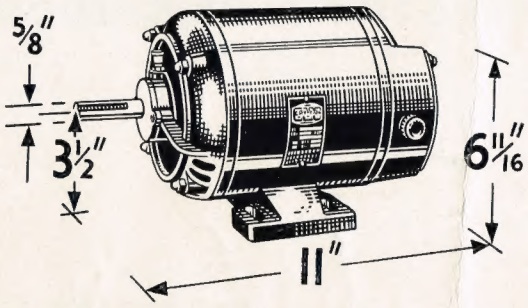

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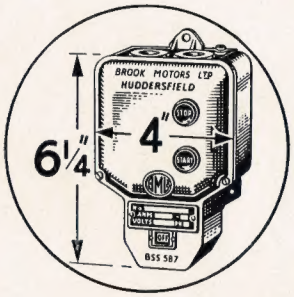

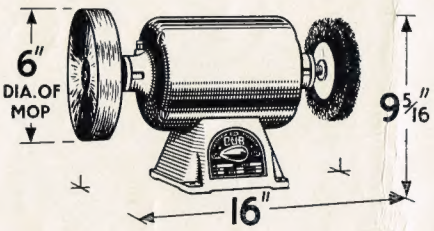

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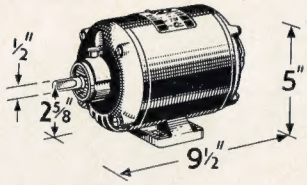

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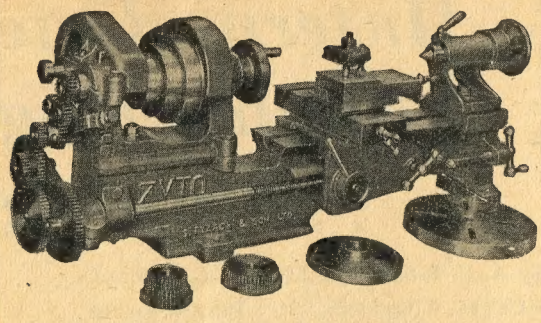

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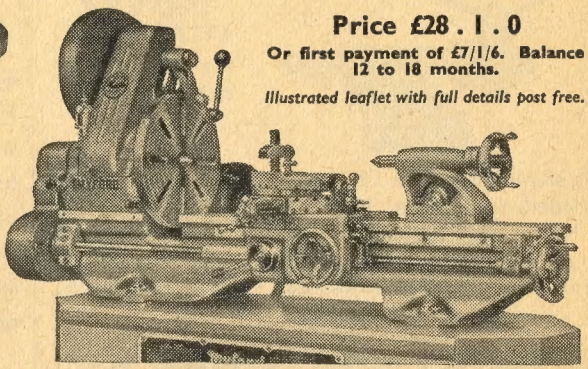

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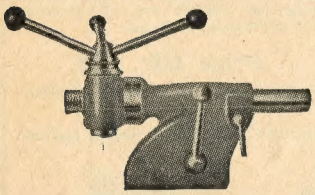

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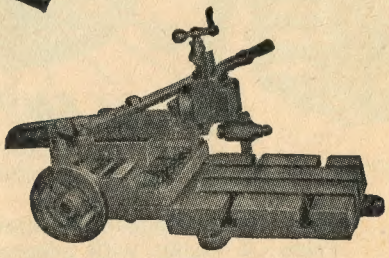

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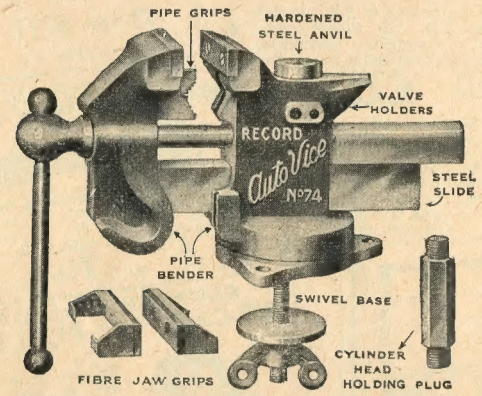

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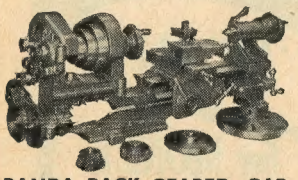

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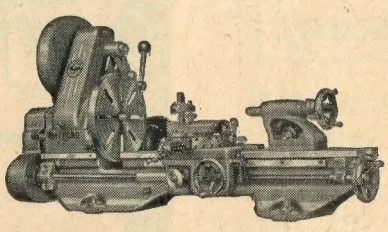

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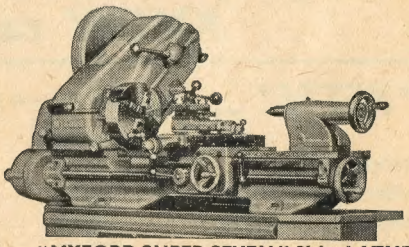

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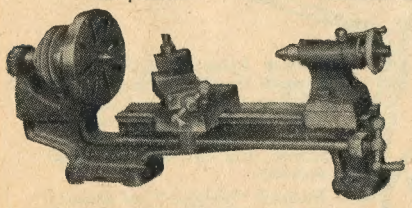

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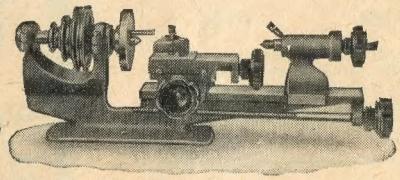

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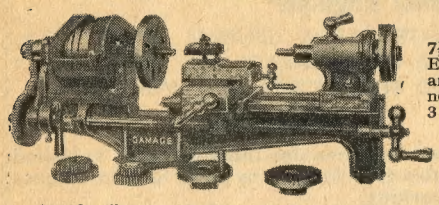

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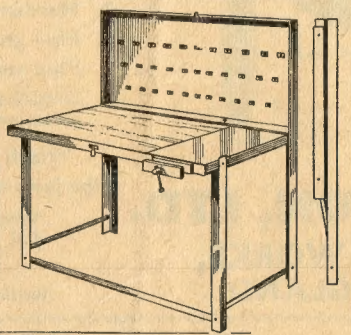

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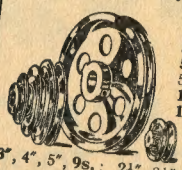

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THE
MODEL ENGINEER

EVERY THURSDAY

Volume 110 - No. 2758

APRIL 1st - 1954

ESTABLISHED 1898

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Our Cover Picture

The model Corliss engine shown in this photograph was constructed by Mr. Herbert F. Spurr, of Birmingham, who contributes some further information and photographs of it elsewhere in this issue. This type of engine is one which has been, and still is, extensively used in full-size practice for driving mills and other industrial machinery. Its special feature is the particular form of valve gear, in which separate valves, having a partial rotary motion, are used for steam and exhaust, with a view to providing quick opening and closing and controlled cut-off, thus obtaining the maximum advantage from the expansive properties of the steam, to give high efficiency and economy. In a compound engine, such as this, the Corliss valve gear is often used only on the high pressure cylinder, the more usual form of slide valve being used in the further stage or stages of expansion.

SMOKE RINGS

Centenary of the L.T.S.R.

THIS YEAR marks the hundredth anniversary of what used to be the London Tilbury and Southend Railway, and in celebration of this event, the British Transport Commission has arranged an exhibition which will be held in the Town Hall, Barking. It will open on Thursday, April 8th, and close on Saturday, April 10th; hours 11 a.m. to 9 p.m. each day. The exhibits will consist of photographs, models, timetables and relics appertaining to the L.T.S.R., and there will be a small charge for admission.

Newspaper Technology

A CYNIC once said: "There is no news in truth—and there is no truth in news!" We do not endorse this extreme view; on the other hand, we have every respect for the topical journalist, who generally carries out his onerous and often thankless job with commendable accuracy and speed. But occasionally a reporter's zeal to obtain a good "story" will obscure his respect for truth, particularly in reporting technical or scientific developments. It often happens that a totally inaccurate or misleading description is given of some new device, and many things which are hailed as new and revolutionary are really ancient history to the engineer. A ship fitted with a gas turbine is usually described in the popular Press as a "jet" boat, and the same term has been applied to turbine-driven locomotives and cars, though in neither case is it technically correct in the accepted sense. Modern computing devices are styled "electronic brains," and a photo-electric detector is invariably a "magic eye," while the unkindest cut of all is to call sound broadcasting "steam radio." In some respects, these terms may help the uninitiated to form mental pictures better than scientific jargon, but unfortunately loose and inaccurate terms are infectious, and even find their way into the workshop and laboratory.

In a flashback to news items of 50 years ago, a daily paper recently stated that *at that date* the first electric clock had been completed by a Frenchman—quite a shock to those of us who have heard of Alexander Bain and also the 1851 Exhibition clock. A semi-technical journal has ascribed the invention of the gyroscope to Sperry, who may certainly be credited with its application to many purposes—but we have an illustration of an electrically-driven gyroscope in a textbook published long before the end of last century!

Newspapers and "popular science" publications undoubtedly serve a useful purpose in drawing attention to the progress of science and engineering, but their reports should be regarded as appetisers, and the seeker after truth will be well advised to follow them up by a more serious study of conscientious technical journals and textbooks.

Andover Traction Engine Rally

IT LOOKS as though there will be a good entry of fine engines for the Traction Engine Rally at Andover on May 1st. Mr. R. Pemble states that they will include the Burrell scenics *Perseverance* and *Prince of Wales*, the Fowler showman's engine *Lion*, and Fodens, Marshalls, Garretts and Sentinels of various types.

The engines should be on the field, in steam, at 12 noon, and the show will open at 12.30 p.m. Events will begin at 2 p.m., the intermediate period being taken up in general inspection and photographing. Car park and refreshments will be available, and admission will be by programme, price 1s.

The Andover and District Model Engineering Society will have some models on view in a marquee stewarded by members of the Flying section. An unusual event will be an "Elegance and General Maintenance" Competition for the full-size engines.

The story of "Squib 2"

THE EVOLUTION OF A FLASH-STEAM DRIVEN MODEL CRUISER

By A. L. Gates

The builder with his flash-steamer "Squib 2"

AFTER many years of experience in the construction and running of model power boats fitted with boilers of different types, I was looking round for some new idea, when one day I witnessed a fine run by a well-known flash-steam hydroplane *Chatterbox* at Victoria Park, London. This set me thinking of the possibilities of constructing a straight-running boat driven by flash steam, and I straight away started to collect data on this subject, and at the same time scrounged all the miscellaneous junk I thought I should need to construct it, consisting mainly of pieces of railings, clocks, locks, fire bars, etc.

In due course the machinery for the boat began to take shape. The engine was of the twin single-acting type, $\frac{5}{8}$ in. bore × $\frac{5}{8}$ in. stroke, having cylinders made of steel tube from old motor-cycle forks, and a crankshaft built from scrap, with bevel gears obtained from Stevens Model Dockyard at the shocking price of eighteen pence per pair. (Those pre-war days !) The overhead slide-valve and steamchest were made from an old lock, and the flywheel from a chunk of sash weight. Other parts made from scrap were the water pump of $\frac{5}{16}$ in. bore × $\frac{5}{16}$ in. stroke, using spur wheels from an old gramophone, a hand-pump of $\frac{1}{4}$ in. bore, and an oil pump of $\frac{1}{8}$ in. bore × $\frac{1}{4}$ in. stroke made from parts of a water tap, and geared down at a ratio of 70 to 1 from the engine, the total cost being 2s. 0d. The boiler was made from copper tube, consisting of 10 ft. of $\frac{1}{4}$ in. diameter, and 6 ft. of $\frac{3}{16}$ in. diameter, joined together and wound round a wooden mandrel. This was enclosed in a tin casing made from an old varnish can, the total cost of the boiler being 2s. 6d.

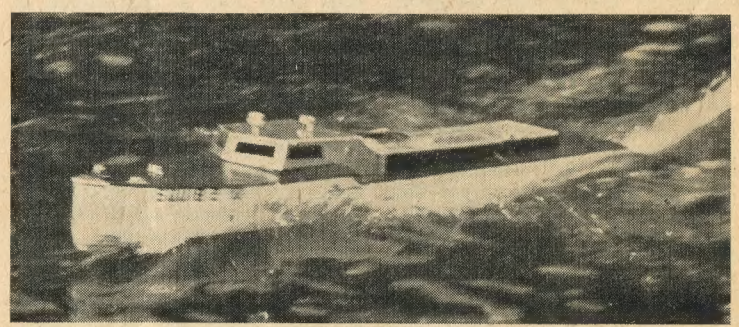
When the whole contraption was completed, it was bolted down and given a bench test with the aid of a plumber's blowlamp. After many adjustments, the engine gave a good account of itself—so did the varnish can, and after I succeeded in groping my way out of the workshop, I set about making the hull from my own drawings. This was 30 in. long by 9 in. beam by 4 in. deep, of the hard chine type, and material cost 2s. 0d. The total cost of the entire boat when painted and finished was 10s. 0d. (a lot of money in those days).

The boat was taken to the nearest pond, which was at Wanstead Flats, the blow-lamp was started and put in, and after a few strokes of the pump and twists of the propeller, the engine started with a howl. I was so surprised, I let go of the boat, and she shot off, laying over to port —due to torque plus no rudder, which had been forgotten in the hurry and excitement of getting the boat ready for test. It ran in a wide arc, and finished up at the concrete edge of the pond, landing high and dry, much the worse for wear. At that point there was quite a temptation to give up the struggle, but I had learned a great deal from the afternoon's experience.

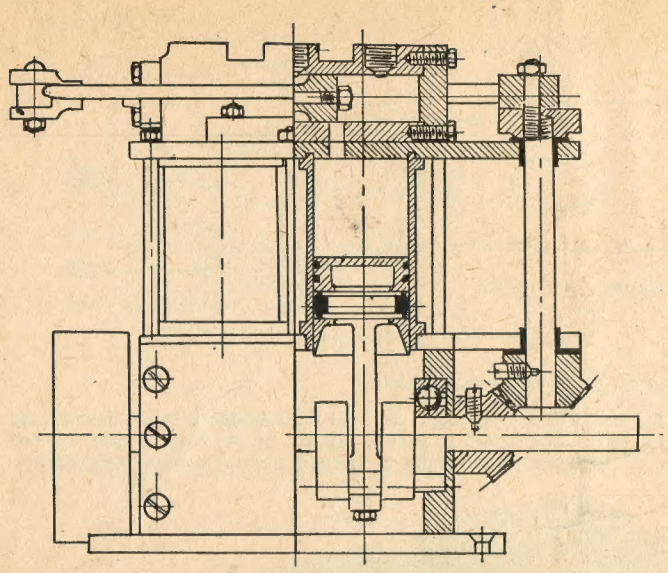
The hull was repaired and a new engine constructed, again a single-acting twin, but enlarged to $\frac{3}{4}$ in. × $\frac{3}{4}$ in. and fitted with a piston valve, as I had found out that slide valves were not suitable for use with flash steam.

This time the cylinders and pistons were made from a piece of fine-grained cast-iron, obtained from a railing post, the rings also being made in the same material, and great pains taken to lap the pistons in nicely. The crankcase was fabricated from dural, with two ball-races in place of plain bushes, and the crankshaft was again built up, pinned and brazed as before.

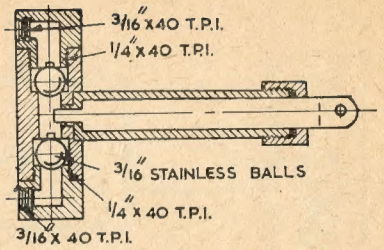
When the engine was assembled, it was timed so that the valve opened to steam 5 deg. before top dead centre. The original pumps were used, but the water pump was bored out to take a plunger $\frac{1}{4}$ in. diameter by $\frac{1}{4}$ in. stroke, and the reduction gear altered to $4\frac{1}{2}$ to 1 instead of 5 to 1.



"Squib 2" travelling at speed



Details of the engine—¾ in. bore × ¾ in. stroke



Water pump ¼ in. bore. Oil pump similar in shape, but ⅛ in. bore

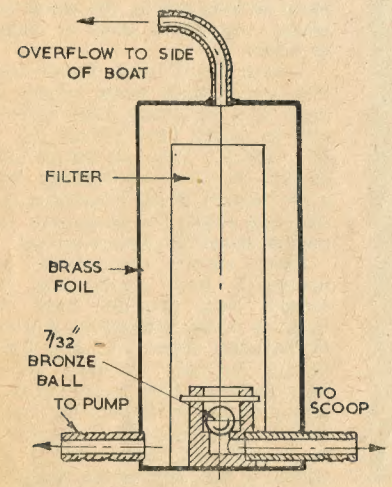
The original boiler coil was used, but re-arranged, and a new blow-lamp made, with a needle valve, which has proved to be a great success. After installing the plant in the boat, I again took it off to the pond for a trial, but due precautions were taken this time to get it to go straight. Soon the lamp was blowing merrily and the engine was humming away. The boat was sent across the pond to the stopper, and came back at the same nice pace of about 10 m.p.h., which was not too fast for convenient handling and stopping, and the run continued till all the paraffin was exhausted.

The steering at first was nothing to boast about, but proved to be capable of adjustment in later runs. Then came the great upheaval, and like many other readers, I found much more important things to do.

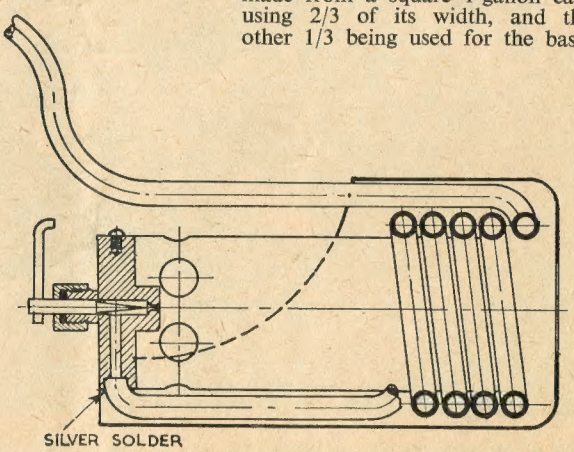
The old boat is still running in the Victoria Model Steam Boat Club, appearing regularly in regattas under the number "13" and it has won 13 prizes up to date. Several modifications have been made, and the hull is longer than it was, having been increased to 50 in., but the beam is still 9 in., and the depth 4 in.

Some hints about the boiler construction may be useful to other readers who are experimenting with flash steam.

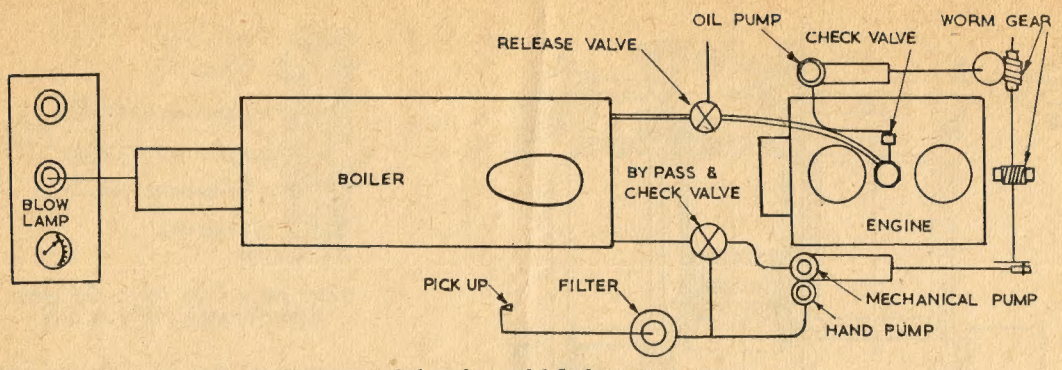
As previously mentioned, this was made from solid drawn copper tube of ¼ in. and 5/16 in. dia., about medium gauge, the lengths of which are joined together by threads, using a reducing socket made from copper, after which the joint was Sifbronzed. A tapered mandrel was made from wood, 12 in. long, and 1¾ in. diameter at one end and 1¼ in. at the other, the small end being the end nearest the engine. About 3 in. of tube is left straight, and then it is wound round the mandrel at the engine end, forming a coil of about 10 in. Six strips of ⅛-in. iron wire are then laid over this coil, evenly spaced round the outside, and the rest of the tube wound back over the first coil towards the engine, leaving sufficient length at the end for connecting to the pump. I have found that when built this way, the heat from the blow-lamp is distributed in such a way that the water is heated evenly, and so stops surging, which is one of the difficulties often encountered with flash steam. The casing for the coil was made from a square 1-gallon can, using 2/3 of its width, and the other 1/3 being used for the base,



Ball valve at base of filter ensuring water always on tap for starting, and prevents air lock



Burner, showing outer and inner casing

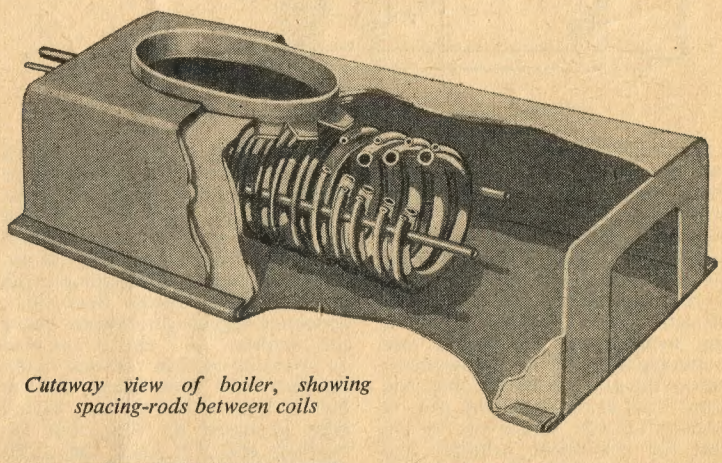


Layout of plant for model flash-steam crusier

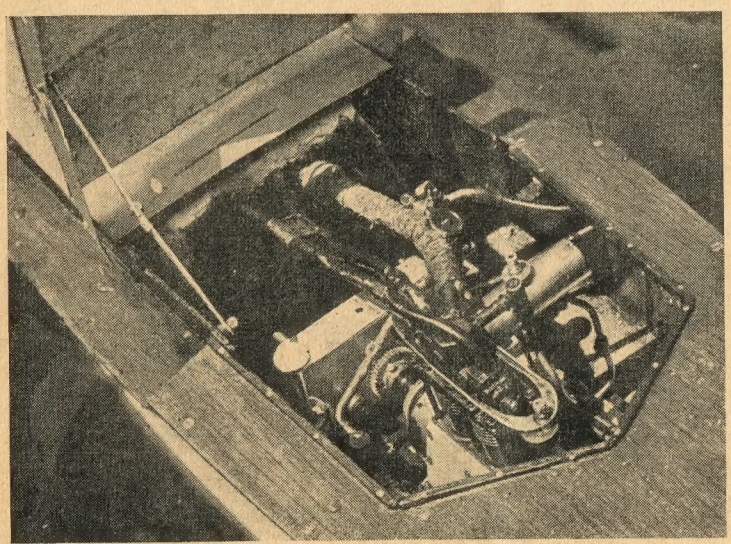
but before this was fixed, the vent for the outlet was made, in the shape of a short funnel of oval section 3 in. × 2 in. The interior of the casing was lagged with ⅛-in. asbestos millboard.

I have chosen copper tube instead of steel tube for the boiler, as I have found this to be best for straight-running boats. The scale produced in copper tube is much softer than the scale of steel and will not damage the engine. This metal is also a fine conductor of heat, and as to its lasting power, it will be found quite durable if treated fairly.

A similar boiler to the one I am using at present can be built in an afternoon at the cost of 17s. 0d. (present day prices), whereas a bought "pot boiler" of similar steam capacity would cost not less than about £2 for material and fittings and take about two days to make and test. The latter is most essential, as it is a very serious thing for a pot boiler to burst, whereas the failure of a flash boiler is not attended by any serious consequences;



Cutaway view of boiler, showing spacing-rods between coils



View of the engine-room, showing gear box to twin screws; also, oil tank to mechanical pump

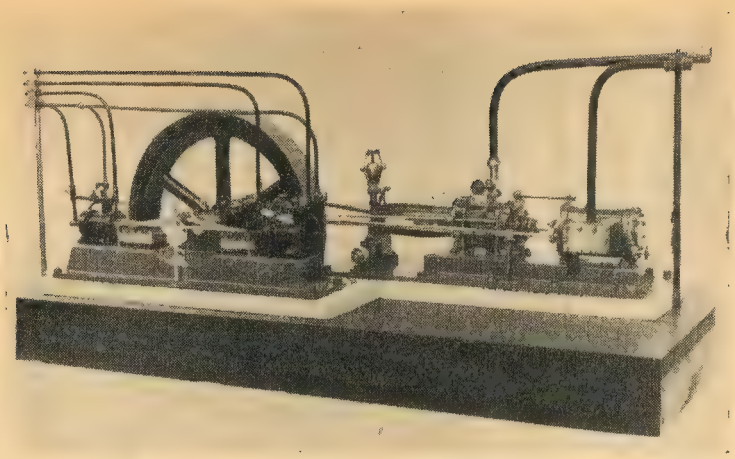
even if it should happen, the weak part can be cut out and another piece of tube put in, the whole job taking not more than a couple of hours.

I have heard many power boat men saying flash steam cannot be controlled, but many other users as well as myself have proved this to be a fallacy. I can run the old boat so that she just potters along, then a few strokes of the blow-lamp and she goes across the pond at a fast enough speed for anyone to stop.

Flash steam boats need not necessarily look untidy and unsightly, and, provided that the boiler is installed properly, you can fit polished decks and any fancy fittings you like. A good deal of information on flash steam has been published in THE MODEL ENGINEER, and the handbook *Flash Steam* will be found very useful, but I am willing to give anyone the benefit of my experience on this subject if they care to get in touch with me through the editor.

A Model Corliss Engine

By H. F. Spurr



Side view of engine, showing opposed compressors driven by single-throw crank

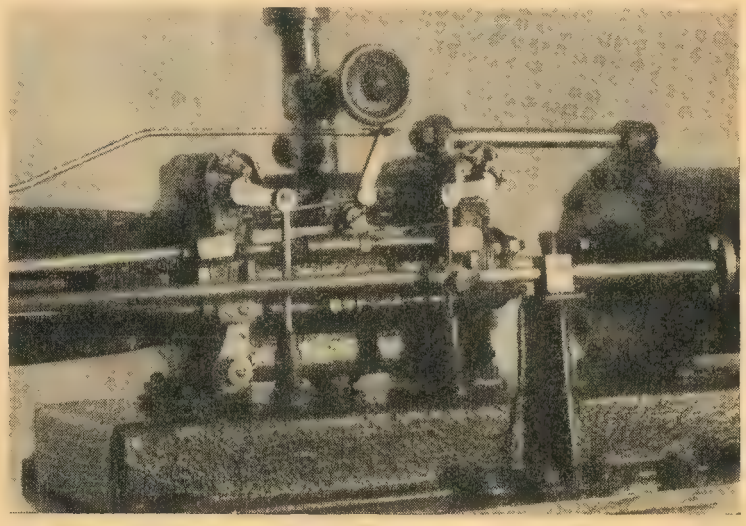
THE model illustrated is based on the main engine of the gear tandem compound Corliss type that was running at the Lindé Refrigeration Co. Ltd., Digbeth, Birmingham, when I was employed there from 1910-1917. This engine is not now in existence, having been installed in 1896 and dismantled in 1923, but I still have an original photograph. It was rated at 105 n.h.p., 68 r.p.m.; the two compressors it was driving are still running, but are now motorised. There were five 2 in. diameter driving ropes to a line-shaft, which in turn drove the various pumps, etc., for the ice-making tanks and cold rooms. When war broke out in 1914, the Lindé was taken over by the Lightfoot Cold Stores Ltd., but these works are now owned by the Union Cold Stores.

As perhaps you will have guessed from the dates I have mentioned, I am an old-timer, being 62 years of age, and I have seen some changes in prime motive power since I was a lad. I have always been interested in model-making, but have only recently been able to indulge in it as a hobby. I began to build a little workshop about five years ago, and have made my own B.G., S.C. lathe, surface grinder, driller, etc., during that time.

The model follows the arrangement of the actual engine, driving two opposed compressors and a line-shaft. The Corliss valves (actual size $\frac{1}{2}$ in. × 5/32 in.) are the inward-rotated pattern, hollow, with two slots, one to live steam, the other to admission ports, thereby giving quicker admission and cut-off. The governor-rod is connected to two cams at the back of the rocker arms, which control the point of release to the catch links. The two pipes and taps seen on the cylinder (engine side) are for indicating. They are 1/32 in. bore diameter and actually work. Lubrication to the crank-pins is by centrifugal drip-feed. The engine is painted sage green, as also is the base of the compressors. Cylinder covers are left bright, and the flywheel, compressors, and four suction pipes are painted black. Delivery pipe from compressor is painted green, and rim of flywheel grey. It has taken me about 1,000 hours to make, and looks a very pretty model under its glass case.

The leading dimensions of the model are as follows: H.P. cylinder $\frac{3}{4}$-in. bore; L.P. cylinder $1\frac{1}{8}$ in. bore; stroke $1\frac{5}{8}$ in.; Corliss valve centres $1\frac{5}{8}$ in. × $1\frac{1}{8}$ in.; compressor, $\frac{1}{2}$ in. bore by 1 in. stroke; main bedplate, 14 in. long; compressor bedplate, 9 in. long.

Reverting back to where I mention the Lindé Refrigeration Co. Ltd., it may be of interest to recall some of the pioneer work that went on in this country in the latter half of the 19th century. Around 1880, Professor Carl Lindé, Professor Mond and others came to England to develop their inventions. Professor Mond was the originator of Mond Gas in Staffordshire, and later Mond Nickel ("Old Nick's Metal," remember Bessemer !) and Carl Lindé developed his ammonia (NH_3) refrigerating machine. The works in Digbeth, Birmingham, were built about 1886, and in 1897 he installed a plant under the Birmingham meat market. (The Lightfoot still run this plant, improved and extended now.) At that time there were two Premier gas engines driving the plant, followed shortly after by the addition of two National gas engines. (I was working on these for three years, and did we have some *happy* times starting up 50 n.h.p. engines when they were cold !).



A close-up of the Corliss trip gear, showing rockers and dashpots

QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

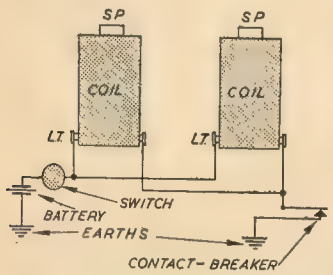
(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Ignition for Twin Engine

I have a horizontally-opposed, "Craftsman Twin" engine as designed by Mr. E. T. Westbury, which I am fitting into a model power boat, but I have so far been unable to obtain a twin spark-coil for it. Could you please advise me where I can obtain one?

T.V.A. (Liverpool, 2).

Dual spark-coils suitable for this engine have been supplied by Messrs. Miniature Ignition, Kirby Close, Ewell, Surrey. We understand that this firm's products have been taken over by Electronic Developments (Surrey) Ltd., 18, Villiers Road, Kingston-on-Thames, Surrey.



If, however, it is not possible to obtain a dual spark-coil, two coils of the normal type could be used with the primary circuits in parallel, but controlled by the single contact-breaker, as shown in the diagram.

Miniature Slide Projector

I am building the "M.E." universal slide projector which was described in THE MODEL ENGINEER *during March, April, May, June, July and August,* 1950. *As I wish to avoid the trouble of fabricating the lantern, can you advise me of the name of any person or firm who could supply castings for this. I have written to Roox Products of Alton, Hants, but they can only supply castings for the single frame strip projector. Do you consider that a 12-volt 36-watt car head-lamp would be sufficiently powerful for use with this projector for projecting colour transparencies?*

P.J.W. (Woodbridge).

This particular projector was intended specifically for the benefit of readers who do not wish to go to the trouble of obtaining castings, and was, therefore, arranged for fabrication from sheet metal.

So far as we are aware, no castings have ever been made for this particular type. It would, however, be quite practicable to utilise the base and lamp house castings of the single frame strip projector for use with this instrument. The front part of the optical system would have to be fabricated.

Colour transparencies need a fairly powerful light for effective penetration but a great deal would depend on how large a picture you wish to project, and a 36-watt motor-car head-lamp, overrun to 15 volts, has been used for colour transparences with fair success, for projection to not more than about 3 ft. in width on the screen.

Castings for I.C. Engines

I am making a 15 c.c. racing engine and should be glad to know whether common aluminium is suitable for crankcase castings.

C.P. (London, W.6.).

The term "common aluminium" does not convey any very definite idea as to the quality of the material. Pure aluminium is unsuitable for castings generally, and the material commonly employed for crankcases contains additions of certain other metals which improve its strength also machining qualities.

The particular alloy specified as D.T.D. 424 is recommended for crankcases and can be supplied by most foundries. Alternatively, scrap metal obtained by melting down motor-car or aircraft crankcases or pistons could be used, but the precise quality of any castings made from scrap is not easy to guarantee, as some of the qualities of the alloy may be lost in remelting.

Joining I.C. Engine Cylinder Blocks

Will you please advise me if it is possible to join together two "1831" engine blocks in line so as to form a 4-cylinder engine block. Also, can you advise me of any firm who would undertake this work? Is it still possible to obtain castings and drawings for this engine?

C.I.C. (Gironde, France).

We are extremely doubtful whether it would be practicable to join two of the cylinder blocks for this engine satisfactorily, and we suggest that it would probably be simpler to make a new pattern and get a casting made. We cannot advise you of any firm who would undertake this work, and in our experience it is extremely difficult to get work of this nature done on small engine components.

We do not favour the idea of joining two "1831" engines end to end, as we think it would be preferable to produce a new 4-cylinder engine design enabling the engine to be made shorter and more rigid than by doubling up the two cylinder blocks.

An engine of 60 c.c. built on these lines should be quite powerful enough for the purpose you have in mind, but the "1831" engine has proved quite capable of propelling a 6 ft. model cargo liner with plenty of power in hand.

Castings for the construction of this engine can be obtained from W. H. Haselgrove, 1, Queensway, Petts Wood, Kent, and drawings can be obtained from these offices, price 5s. 6d. for a set of two sheets.

Traction Engine Boiler

I am contemplating building a 1½-in. scale traction engine (R. S. & J., Ipswich, prototype) and the price of copper plate and tubes for the boiler appals me. I intend to work at 80 p.s.i. pressure. Would you please tell me what thickness of plate I should use, in steel, for wrapper plate and tubeplate; also, size of steel rivets, as I intend to rivet and caulk instead of silver-soldering and brazing.

J.N. (Ipswich).

For a steel boiler we recommend 5/32 in. plate throughout, except for the tubeplates which should be $\frac{3}{16}$-in. thick, at least. If you use steel flue-tubes, 15-gauge should be their thickness; but 17-gauge brass would be more efficient. Rivets should be $1\frac{1}{2}$ times the plate thickness in diameter, spaced $3\frac{1}{2}$ to 4 times their diameter.

A Research MICROSCOPE

by Lawrence H. Sparey

AS a reasonable time has elapsed since the publication of the last constructional article on this microscope, it is to be assumed that a good number of instruments will be nearing completion; in fact, I am aware of several that are already working. A few words, therefore, on the choice of optical equipment would seem to be in season, while a little advice on the use of the instrument may help the inexperienced towards good results.

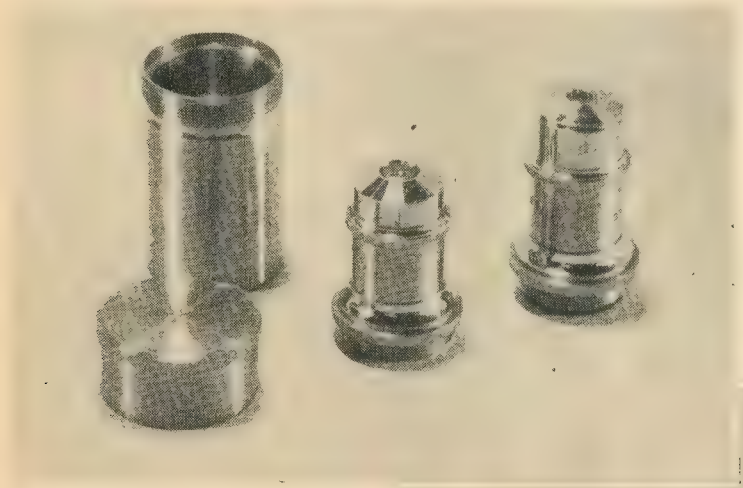
Objectives

The compound lens arrangement of the modern microscope objective has been brought to a high state of perfection; so much so, indeed, that the cheaper class of lenses—known as the "Student" type—at one time frowned upon for serious work, is now quite adequate for anything but the highest class of research. During the later part of the last century, researches into new types of optical glass, financed by the Prussian government, resulted in the production of the *Apochromatic* objectives in which aberrations of both colour and image were practically eliminated. When viewing an object with cheap and inferior objectives, it may appear to be surrounded by a false spectrum image, due to the fact that each colour of the spectrum, of which white light is composed, is refracted, or bent, a different amount when passing from one transparent medium to another. The image, therefore, is surround by a fringe of the spectrum colours which have been displaced. Apochromatic objectives, using lenses of fluorite and special glasses, correct this bending of the light rays, so that an image having no colour displacement is obtained.

Such lenses are extremely expensive, but need not, fortunately, be considered by the amateur, who will find all he needs in the student types supplied by any well-known manufacturer. These lenses, known as *Achromatic* objectives, are now so well corrected that they do in many instances, seriously compete with the apochromatic types. The better class of achromatic lenses are, in fact, now generally known as *semi-apochromatic*, and they are to be highly recommended. It may be said, then, that unless one is embarking on highly original research, the apochromatic lenses may be ignored.

Eye-pieces or Oculars

The true apochromatic objectives require specially corrected eye-pieces to be used with them, but as we have agreed that the achromatic lenses will meet our requirements, the eye-piece commonly used with the microscope is all we need. This is known as the Huyghenian eye-piece, which is a simple combination of two plano-convex lenses.



Microscope objectives. That on the left is a 2/3rd-in., while that on the right is a 1/6th-in. An objective case is also shown which prevents rattle and holds the lens from contact with any surface

Eye-pieces, or oculars. The magnification (left to right) ×15, ×10, and ×6

Continued from page 520, Vol. 109, October 29, 1953.

These may be had in various powers of magnification, but, as has already been pointed out in a previous article, little is to be gained for any ordinary purpose by the use of eye-pieces of extremely high magnification. For general use the amateur will find that eye-pieces with a magnification of $\times 5$, $\times 10$, and $\times 15$ will give all he requires.

Magnification of Objectives

Most of the modern objectives are designed for use with an instrument having a tube length of 10 in., and this is in accord with our own microscope. The magnifying power is always expressed as a measurement; that is, an objective will be said to be a 1-in., a ½-in., a 1/6-in., etc. Without going into a lengthy explanation of the whys and wherefores, it may be said at once that a 1-in. objective, when used with a tube length of 10 in., give a magnification of 10 times. In like manner, a ½-in. objective will magnify 20 times under like conditions, and a 1/6-in. by 60 times, and so on. We thus see that it is necessary only to multiply the lower figure of the fraction by the tube length to obtain the magnification.

This inherent magnification is, of course, again multiplied by the power of the eye-piece; thus, a 1/6-in. objective, used with a $\times 10$ eye-piece, will produce an actual magnification of 600 times, with an instrument of 10 in. tube length.

The novice may be puzzled by a term used in the description of objectives; i.e. Numerical Aperture, or N.A. as it is usually written. Without going into technical explanations beyond the scope of this article, it may be said that N.A. is a term of reference to the amount and angle of light which an objective will pass to form an image. The larger the numerical aperture of an objective, the more its resolving power. Also, the more its price and the difficulty of handling it correctly.

Special microscope lamp made by the writer. This incorporates a filter-holder, racking lens adjustment, and a swing-out, centring lens holder. Adjustable for angle and height. Illumination is by a bunched-filament car bulb, working at 6 volts through a transformer from the mains

Immersion Objectives

It is a well-known law of optics that a ray of light passing from a denser to a rarer medium is refracted, or bent, away from the perpendicular. When, therefore, we view an object through a microscope using an ordinary objective, some of the rays of light, passing from the object, will be bent outwards as they pass from the cover-glass of the specimen-slide to the rarer air lying between the slide and the lens of the objective. Many of these rays will be bent so far from the perpendicular as to miss the objective lens altogether, so that by that much is our resolving power diminished.

If, however, we replace the layer of air by some medium having a refractive index similar to that of glass, so as to form a continuous body between specimen and lens, the light rays will not be bent outwards, but will pass through the objective lens. The commonly used medium is *cedar-wood oil*, which has a refractive index practically the same as that of crown glass.

The cedar-wood oil is applied as a small globule to the objective lens, and is brought carefully into contact with the cover glass of the specimen slide, thus forming a continuity. The elasticity of the oil globule allows of sufficient movement for focussing purposes. A very considerable increase in the resolving power of the lens, the brilliance of the image, and the working distance is gained.

Oil immersion lenses are usually those of high power; that is, of ⅛-in. or 1/12-in., as it is at these high magnifications that the gain is most useful and apparent. It must be pointed out, however, that only special oil-immersion objectives must be used, which are specially corrected, and proofed against entry of the oil.

Chosing Objectives

The selection of objectives must, of course, depend upon the type of work one intends to carry out, but for the novice and general operator

it may be said that the best objectives are a 2-in., a 1-in., a 2/3-in. and a 1/6-in. The average microscopist will, in fact, derive more pleasure and interest from the objectives of low power than from those of high.

The reason for this is that the field of view yielded by the higher powers is restricted to a small portion of the specimen. Thus, for instance, when viewing an insect; while the structure of the scales or skin may be determined under the higher powers, the general aspect of the specimen, and the relation of one part to another, may be difficult to comprehend. Like reading a book letter by letter. The novice is, at first, usually fascinated by the higher powers, but as experience grows he will find that the lower powers add most to his knowledge and enjoyment.

On the other hand, when skill in adjusting and setting up the instrument has been attained, the amount of detail which can be seen with the lower powers is surprising. I have regularly viewed the bacteria in a spot of my own saliva using a 1/6-in. objective, and have visually demonstrated to my children the necessity of using immediately an antiseptic on cuts and abrasions. The Elastoplast and the "disinfectant" are in constant demand now that they have seen how all the wriggling movements of the bacteria stop when the spot of saliva is touched with a needle dipped in "Dettol"!

As the fascination of the microscope grows, you will undoubtedly wish to add a 1/12-in. oil-immersion lens to your outfit, for with this you will be able to explore the wonderful minute structures that comprise familiar things. But wait until you have learned to handle your instrument correctly—otherwise you will be disappointed.

The Substage Condenser or Illuminator

The importance of correctly lighting the object has already been emphasised in these articles, and nothing contributes more to this end than the substage condenser. While the mirror alone may be sufficient when using the lowest power objectives, the object becomes badly defined, and the whole field dark, if no substage condenser is used, when using any lens above ½-in. power.

While special condensers may be obtained for specialised purposes, the amateur will be best suited by that known as the *Abbe* illuminator, which has the advantages of being cheap, efficient and easily handled. The modern Abbe condenser, as marketed by the leading optical firms, is usually an improved type of the original condenser invented by Prof. Abbe in the last century. Any of the well-known manufacturers, such as Watson, Baker, Swift, to mention only a few, will be pleased to advise.

Microscope Lamps

The original source of illumination during the early days of the microscope was the oil-lamp usually made specially for the purpose; but the modern microscopist will undoubtedly wish to avoid this troublesome and smelly accessory. Electric light is the answer, and the model engineer will build himself a suitable lamp as soon as possible. For reasons of safety it is desirable to use a low voltage lamp—say 4 or 6 volts—and this may be powered by a battery or through a transformer from the mains. The latter is particularly to be recommended, as one may then use a bunched-filament car lamp, which is cheap and easily obtained. Failing this an ordinary pocket-lamp bulb, used with a battery, will give sufficient light for any purpose. It is advisable to fit a dimming rheostat so that the intensity of the light may be controlled.

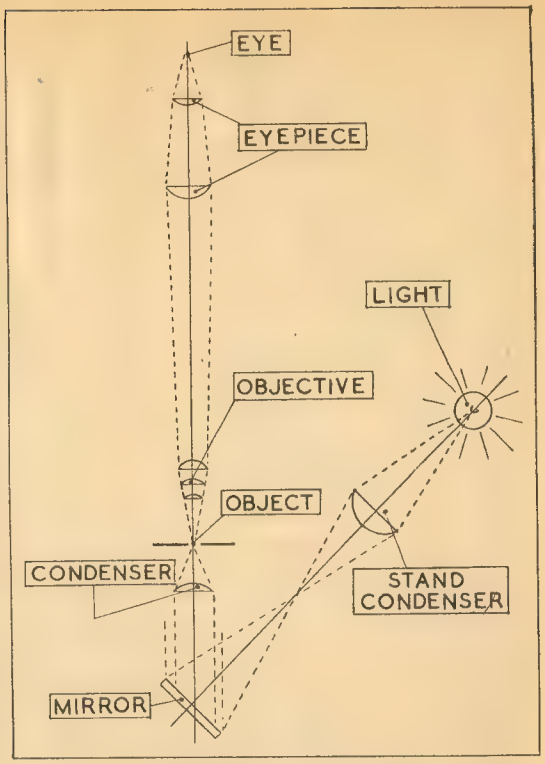


Diagram showing the set-up for projecting a beam of light through the microscope

The illustration shows my own lamp which is made entirely from dural. As may be seen, it may be tilted and raised-and-lowered upon the column. The lamp-house holds a S.B.C. lamp-holder, to take a car bulb, and the housing-slot to accommodate an opal diffusing glass, or colour filters, will be noted.

To the lower part of the limb is attached a housing for a plano-convex condenser lens, and this housing has a centring-device and swing-out movement similar to that of the condenser-housing on the microscope itself.

The lens may be positioned by a rack-and-pinion movement. While the lamp is rather elaborate, it is an ideal accessory for the purpose, and is most convenient to use.

In the lamp shown, the plano-convex, or "bull's-eye," lens is incorporated as part of the lamp itself, but if a plain lamphouse is used it will then be necessary to have, in addition, a separate *stand-condenser*, to interpose between the light source and the mirror of the microscope. This enables the field to be evenly illuminated.

A stand-condenser may be purchased from any of the suppliers, but it is not a difficult thing for the model engineer to construct for himself. It consists simply of a base and upright pillar, to which is attached a cross-arm carrying the bull's-eye lens, in such a manner as to give universal movement. The stand-condenser is also necessary when viewing opaque objects which cannot be lighted from below. The bull's-eye is then adjusted to throw a spot of light upon the object on the microscope stage.

Critical Lighting

In order to obtain the fullest resolution and maximum lighting of the object, it is necessary that the

light-cone from the substage condenser be focussed exactly upon the object to be viewed. It is for this reason that the substage may be racked up-and-down beneath the stage of the microscope.

Before commencing operations, it is necessary that the microscope, the lamp, and the bull's-eye stand-condenser be set up, so that a beam of light is projected through the microscope, as shown in the diagram on page 345. The plane side of the mirror should be used, and the plane side of the bull's-eye should be towards the lamp.

The lens of the substage condenser must now be centred with the optical axis of the microscope, by means of the centring-screws provided. To do this, make a very small spot on the top lens with a pen and ink, and centre this by viewing through a 1-in. or ½-in. objective. Then wipe off the ink spot.

Now place on the stage of the instrument the slide of the object to be viewed, and carefully rack up the substage condenser until its top lens just touches the underside of the slide. In like manner, rack down the objective until it also just touches the cover-glass of the specimen slide. It may now be necessary to make some adjustment to the lamp and mirror so that the whole field is evenly illuminated. Then rack the objective upwards until the object is focussed sharply into view.

We may now focus the substage condenser. To do this, the bull's-eye stand condenser must be removed, or swung out of the way if a lamp similar to that illustrated is used. Leaving the objective still focussed upon the specimen, the substage is now racked downwards until *the image of the lamp filament is seen sharply focussed in the centre of the field*, the remainder of the field being comparatively dark. The bull's-eye condenser may now be replaced, when the whole field will be evenly illuminated. The intensity of the light may be adjusted to a comfortable level, either by closing the substage iris diaphragm, or with the rheostat on the lamp.

Critical Illumination

We have now obtained what is called *critical illumination*, the only condition under which an objective can give the best performance of which it is capable, with transmitted light.

If the substage is not now touched, any power objective may be substituted for the lower power with which the adjustment was made, the specimen remaining under critical illumination irrespective of the objective used. If the specimen slide is changed for another, however, it may be necessary again to carry out the procedure, because the glass slides vary in thickness, so that the specimen may not always be at the same distance from the substage condenser.

Care of the Microscope

As all of us have made our own microscope we are well aware of the care and precision which has gone into its manufacture, so that we will readily appreciate the destructive effects of dirt and dust. The instrument must, therefore, be housed in a dustproof box or under a glass shade, and be kept scrupulously clean, dusting with a fine camel-hair brush, and wiping with a silken cloth. Oiling should be undertaken sparingly, using a watchmakers' oil.

It is not advisable to unscrew the microscope objectives. They may be seriously deranged if they are not assembled correctly. Should it be necessary for any reason to dismantle an objective, marks should be made on the various component parts, as a guide to reassembly. Great damage may also be done by wiping the lenses with a coarse cloth which may cause scratches. Probably the best thing to use is a soft, tissue paper handkerchief—the things you use and burn when you have influenza !

Particular warning must be given of the danger of racking down the drawtube so as to run the front lens into the cover glass of the specimen slide. This has been done time and again, often with sufficient force to crack the cover-glass. The mishap is most likely to occur when using the high-powered objectives, as the working distance of these is extremely short.

What to Look At

When the famous painting, the Giaconda, was stolen from the Louvre, more people came in a week to view the empty space upon the wall than had seen the masterpiece in two years; so he would be a bold man who would attempt to say what sights people are most interested in.

With the microscope, the case is, perhaps, somewhat different, because under its magic the most common and familiar things take on a beauty and interest not dreamed of. For many weeks, therefore, the beginner will find endless wonders in such prosaic things as paper, wood, and the parts of flowers and plants. Insects, too, are most interesting and wonderful things to study. They may be killed quite painlessly by placing them in a stoppered bottle, with a piece of ether-soaked rag in the bottom. Skin, scales, and hair are also ideal subjects.

Specially-prepared slides of almost everything under the sun, may be had from the dealers, and they are not unduly expensive. I most sincerely advise you to obtain slides of the *diatoms*—those minute frameworks of microscopic algae. If you can view these without gasping, then your soul is dead. On the other hand, medical slides are usually uninteresting for the layman, as they can appeal only to those who know what they are looking at. The liver of a drunkard looks the same to me as that of the leader of a Band of Hope, although I am assured that there is some considerable difference.

[We know that a large number of our readers are making the microscope which has been described by Mr. Sparey in these articles. We have seen and tested the author's own example and found it an excellent instrument that fulfils all the claims he made for it. We shall be pleased to receive photographs of any of the Sparey microscopes made by our readers.—ED., "M.E."]

★ *Our Cover Pictures*

Readers of *THE MODEL ENGINEER* are invited to submit for consideration photographs which may be suitable for cover pictures. The subject must be within the scope of this journal and reference to the covers of this year's issues of the "M.E." will give an indication of the type of photograph preferred. If accepted for publication, a reproduction fee of two guineas will be paid.

Prints should be addressed to . . .

The Managing Editor
THE MODEL ENGINEER
19-20 Noel Street
London W.1

L.B.S.C.'s "Netta"

A NORTH-EASTERN T-CLASS "MITEY" HAULER IN FIVE GAUGES

BEFORE pressing the wheels on, and fitting the coupling-rods, the eccentric sheaves, and in the two smaller sizes, the stop collars, must be erected on the driving axle. On the baby quin, there is another job as well, viz. to make and fit the eccentric straps, as they are one-piece jobs. I detest fiddling about with teeny-weeny screws when it can be avoided, and hate putting them in places where the little so-and-so's can work loose and drop out without any warning; but at the same time I use them in places where they are in sight, and where a larger size would look clumsy. Loud cheer from Inspector Meticulous! If you turn back to page 170 in the issue of February 18th last, you'll see in the top left-hand corner, a drawing of the straps for the "O"-gauge engine. They can either be made from castings, or cut from $\frac{1}{8}$-in. sheet brass. In the former case, the casting can be chucked in the three-jaw and the hole bored out to a nice running fit on the tumbler, facing off one side at the same setting. Then reverse in chuck, and face the other side to bring the strap to correct thickness. It doesn't matter about the strap running axially true for this; I usually put a washer between the strap and the chuck jaws, to pack out the strap sufficiently, to avoid hitting the chuck jaws with the facing tool. Smooth the outside with a file, drill and tap the lug, to take the eccentric rod, and that's that.

If making the straps from sheet, proceed on Pat's principle of building a barrel around the bunghole. Mark the outline of the strap on a bit of sheet brass of requisite size, centre-popping the middle. Chuck in four-jaw with the pop-mark running truly, then put a $\frac{1}{8}$-in. drill through, following with a $\frac{3}{8}$ in. and finally boring the hole to fit the tumbler. Saw and file away the surplus metal around the hole, drill and tap the lug, and you're through.

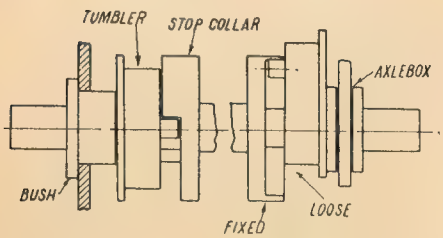
Put one strap on each eccentric, then poke the end of the driving axle through one of the third pair of bearing bushes; thread the eccentrics and stop collars on the axle, between the frames, in the order shown in the accompanying illustration. Push the end of the axle through the other bush, and put the other driving-wheel on by hand, as far as it will go, setting the crankpins at right-angles, as near as you can "by eye."

The assembly for the $1\frac{3}{4}$-in. gauge engine is done in the same manner, whether bushed bearings or sprung axleboxes are used. The straps for this size are of the usual split type, so they don't have to be fitted before the eccentrics are assembled on the axle.

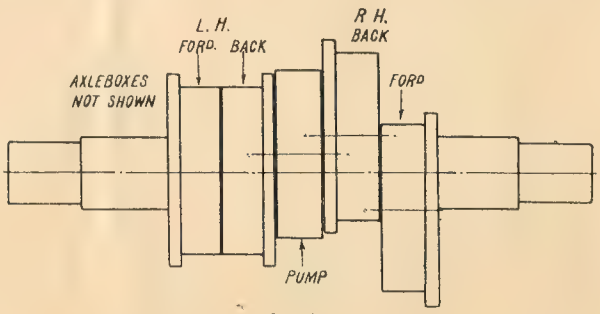
Larger Sizes

In the care of the two small quins, with bushed bearings, or axleboxes with riveted hornstays, the erection of the eccentrics must of necessity be done with the bearings in the frames; but with the larger sizes, it will be more convenient to remove the axleboxes. The very important thing is to avoid putting the axleboxes on the axles either "inside out" as the kiddies would say, or at opposite ends to their location in the frame. In the $2\frac{1}{2}$-in. gauge size, if you haven't already pressed one of the driving wheels on the axle, do it now; then put the axlebox on, flange next to wheel. The eccentrics are then assembled on the axle in the order shown; two motion eccentrics, with the flanges outside, then the pump eccentric, finally the other two for the other side of motion. Then put on the other axlebox; set the crankpins as nearly at right-angles as you can by eye, when putting on the other wheel by hand, as far as it will go. Replace axleboxes in the horns, and put the hornstay screws in. Put a little bit of $\frac{1}{8}$-in. rod, square for preference, between the bottom of axlebox and hornstay, and tighten the spring-pin nuts to hold the bit of rod in place. The axleboxes will now be in running position, and the wheels should spin freely.

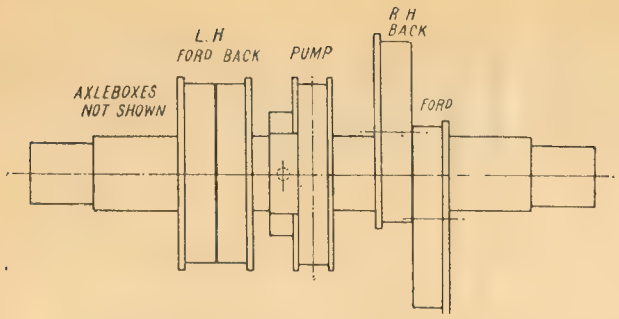
The eccentrics on the $3\frac{1}{2}$-in. and 5-in. gauge engines are assembled and erected in precisely the same way; the arrangement is shown in the illustration. It doesn't matter



Eccentric assembly for gauges "O" and "1"



Eccentric assembly for $2\frac{1}{2}$-in. gauge



Eccentric assembly for 3½-in. and 5-in. gauges

which side of the pump eccentric the boss is located. The 3½-in. gauge axleboxes need bits of ⅛-in. rod for packing, but $\frac{3}{16}$ in. will be required for the 5 in. axleboxes.

Quartering Wheels

The cranks of the driving wheels need to be set at right-angles. Whilst they should be as near the 90 deg. as possible, a wee shade off the 90 doesn't make any appreciable difference to the working of the engine, *provided that all the other cranks are set likewise*. Many and varied are the devices that I have seen, and heard of, for setting the cranks; some builders go to the trouble of making special jigs, others do the job in the lathe and so on. Everybody to his own taste ! All I do, is to use my scribing-block and try-square. In the present instance, I would lay the frames upside down, with the wheels in the air, on some true surface, such as a surface plate, or the table of the drilling-machine or miller. The try-square is set with the edge of the blade cutting across the centre of the axle and crankpin. The needle of the scribing-block is then set to the centre of the axle on the other side, and the wheel adjusted on the axle, until the scriber point touches the middle of the crankpin.

The correct setting is shown in the illustration, which I have shown many times before, but now offer again, for the benefit of newcomers to our craft, at their request. When the wheels on both sides are in the position shown, at the same time, in relation to the square and scribing-block, the setting is correct and the wheels can be pressed on just sufficiently to prevent moving on the wheel-seats.

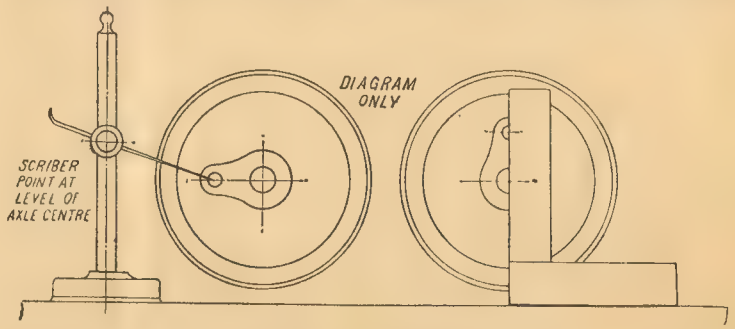
There is no need to apply the square and scriber to the rest of the wheels. Put the axles, with one wheel on each, through their respective boxes, and put the other wheels on by hand, setting the cranks as near right-angles as possible, by eye, as before. Don't forget to put the eccentric for driving the lubricator, on the first axle of the 3½-in. and 5-in. gauge engines. Put the coupling-rod on one side, with a nut on the first and fourth pins, to keep it from slipping off. Then put the coupling-rod on the other side, adjusting the wheels as required, to enable the crankpins to go through the bushes in the rod. To get the whole lot of wheels to turn freely, without any tight places, is then only a matter of careful adjustment of the wheels on the axles. Note that each pair of axleboxes must be blocked up to running position, same as the driving axle. When the wheels will all spin freely, with the coupling-rods on, they are correctly quartered, and can be pressed right home.

The pressing can be done, in the case of the two smaller quins, with the wheels in place in the frame, using the bench vice as press. The larger ones will have to be done separately. If the bench vice jaws won't open out wide enough to accommodate the wheel-and-axle assembly, the only thing to do, is to rest the boss of one of the wheels on an anvil, block of iron, or something equally solid, and carefully drive the wheel home with a soft-metal hammer. I use a bush-and-mandrel press, a present from the late Bro. Wholesale, which will do the job with an axle 11 in. long. Incidentally, I use the same gadget to press in weeny injector cones. Warning: When removing the already-set wheels for the final press home, be careful to avoid any chance of shifting them out of adjustment, or the whole ceremony will have to be repeated.

I'm quite aware that there are umpteen other ways of doing the job, and naturally everybody thinks his own pet way is the best ; but of all the methods that I have tried, I found the above most satisfactory and speedy. Incidentally, I usually erect the wheels before making the coupling-rods, use dummy rods for erecting (simply plain strips of metal with holes for crankpins drilled in them at correct centres) and use the dummies as jigs when making the proper coupling-rods. The few good folk who have spun the coupled wheels of my *Britannia*, by hand, and noted the freedom of running, with no appreciable play in the coupling-rod bushes, can vouch for the efficiency of this method.

Feed Pump for 2½-in. Gauge Engine

The gauge " O " quin won't need an eccentric-driven feed pump. I don't recommend one for the 1¾ in. job, either, as it will run for quite a long while with one filling of the water-tube boiler, and it is only a minute's work to replenish the boiler with the tender hand-pump. When at Norbury, I rebuilt a professionally-made 2-8-0 for a friend, a gauge " 1 " job with a boiler similar in size to that which I shall specify for the 1¾ in. gauge *Netta*. This engine would run for 40 min. nonstop, hauling 16 coaches, on one " pump-up "; and by the time *Netta* had run around a continuous track on the same job, I'd be dizzy through watching her ! Anybody riding



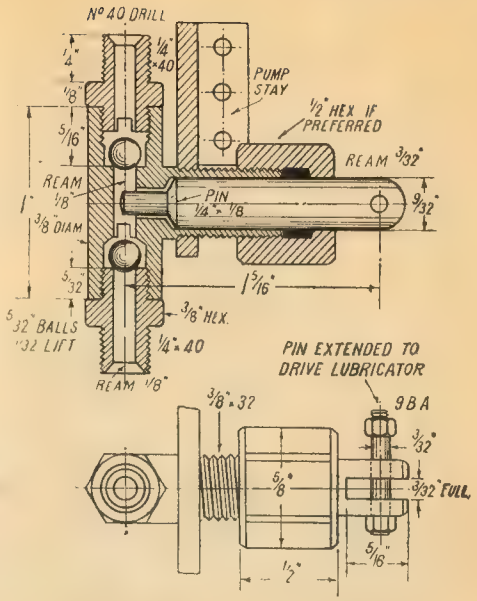
Simple way of quartering wheels. Set L.H. crankpin at top, when R.H. points to front of engine

behind her (she would haul an adult) could easily put a drop in with the hand pump while running. However, if there is any call for an eccentric-driven pump for the gauge "1" quin, I'll be glad to give a drawing, although anyone with the average amount of gumption, could fit one on his own, using the instructions below. It should be $\frac{3}{16}$ in. bore and $\frac{1}{4}$ in. stroke, and feed through a loop in the space between the inside boiler barrel and the outer casing, thus mopping up a few "therms" that would otherwise be wasted.

The sectional drawing and plan of a suitable pump for the $2\frac{1}{2}$ in. gauge quin, is shown here; it is 9/32 in. bore and $\frac{3}{8}$ in. stroke, which is ample for supplying the boiler under any condition of working, and doesn't mop up too much power to drive. In fact, for running on a continuous track the bore could be reduced to 7/32 in. and still put in all the water needed, provided that the workmanship was about right. The body of the pump may either be a casting, or built up. If the former, it will have a chucking-piece cast on opposite the barrel. To machine the casting, first chuck in three-jaw by one end of the valve-box, setting the other end to run truly. Face, centre, and drill right through with No. 34 drill. Open out and bottom to $\frac{5}{16}$ in. depth with 7/32-in. drill and D-bit; slightly countersink the end, and tap $\frac{1}{4}$ in. × 40, taking care to avoid touching the D-bitted seating. For new readers' benefit, the easiest way to chuck the job for machining the other end, is to put a scrap bit of rod in the three-jaw, turn down about $\frac{3}{16}$ in. of it to $\frac{1}{4}$ in. diameter, screw it $\frac{1}{4}$ in. × 40, and screw the machined end of the valve-box on it, repeating operations except that the D-bit is not required. Instead, nick the end of the hole, as shown, with a little chisel made from a bit of $\frac{1}{8}$-in. silver-steel.

Next, chuck by the spigot opposite the barrel, and set the latter to run truly. Face the end, centre, drill right through into the valve-box with No. 30 drill, and open out to $\frac{5}{8}$ in. depth with 9/32-in. drill. Turn the outside to $\frac{3}{8}$ in. diameter, and screw $\frac{3}{8}$ in. × 32, to within $\frac{1}{16}$ in. of the valve-box, facing the end to bring the barrel to $\frac{5}{8}$ in. length. If much has to be taken off the end, it would be advisable to run the 9/32-in. drill in again, as the inside and outside must tally. Run a $\frac{1}{8}$-in. parallel reamer through the remains of the No. 34 hole in the valve-box, which will true the seating and clear away any burring. The chucking spigot can then be sawn off, and the stub smoothed away with a file.

Seat a 5/32-in. rustless steel ball on the D-bitted seating, holding a bit of brass rod on the ball, and giving it just one sharp crack with a hammer; then take the depth from ball to top of recess, with a depth gauge. Chuck a piece of $\frac{3}{8}$-in. hexagon rod in three-jaw, face the end, and turn down to $\frac{1}{4}$ in. diameter, a length 1/32 in. less than indicated by the depth gauge; screw $\frac{1}{4}$ in. × 40, and part off at $\frac{3}{8}$ in. from the shoulder. Rechuck in a tapped bush held in three-jaw; turn down $\frac{1}{4}$ in. length to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. × 40. Centre deeply with size "E" centre-drill, and drill through with No. 40 drill. Cross-nick the bottom with a thin flat file, and assemble as shown.



Feed pump for 2½-in. gauge engine

Drop another ball in the other end, take depth with gauge as before, chuck the $\frac{3}{8}$-in. hexagon rod again, and repeat operations as above, but this time, turn to same length as indicated by depth gauge. Reverse and rechuck in the tapped bush, centre, and this time drill No. 34, and put a $\frac{1}{8}$-in. parallel reamer through. Reverse again in tapped bush, and face just 1/32 in. off the flat end, to get a true seating for the ball. Seat the ball on it with a blow from something softer than itself, such as a copper or brass hammer, and assemble as shown.

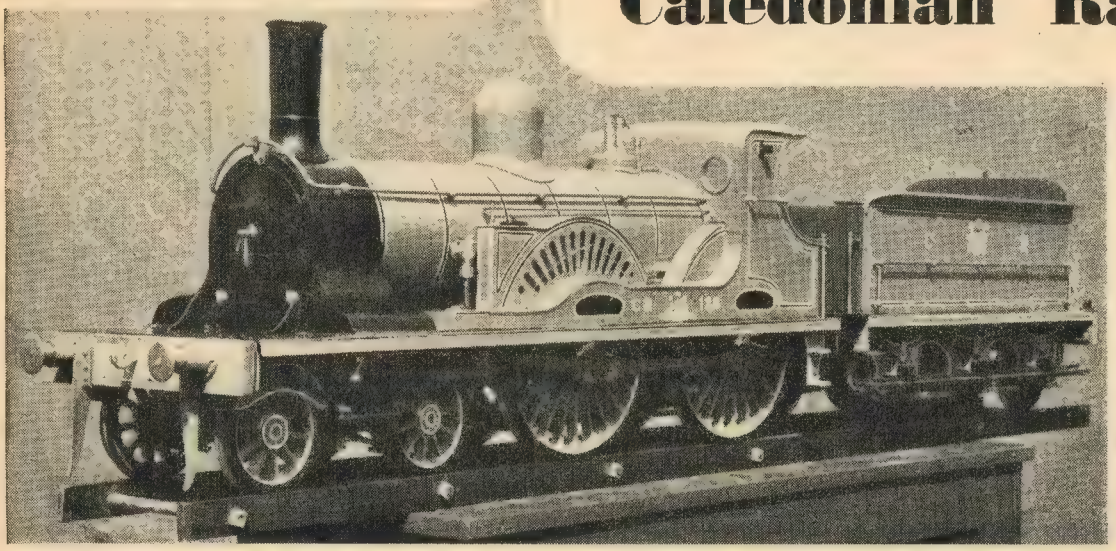
The ram can be made from a $1\frac{1}{2}$ in. length of 9/32-in. rustless steel or bronze, ground or drawn will do. If this size isn't available, turn it from nearest larger. One end is reduced to $\frac{1}{8}$ in. diameter for $\frac{1}{4}$ in. length, to form the anti-airlock pin. At $1\frac{5}{16}$ in. from the end of the pin, drill a No. 43 hole right across the ram, then slot it down for a depth of $\frac{5}{16}$ in. by the same process that I have described for valve gears; clamp it under the slide-rest tool-holder, packed up to centre-height, and run it up to a cutter of the usual saw-type, 3/32 in. wide, on a stub mandrel held in the three-jaw. Incidentally, I still have some of these cutters in use, which were "Government surplus" purchased from Buck & Ryan's for a few pence apiece, after the Kaiser's war. Those *were* the days to go shopping for bargains, ye ken! Round off the end of the ram, as shown, and make a 3/32-in. pin to fit the hole, from a bit of round silver-steel. Reduce each end to 5/64 in. and screw it 9 B.A. to take a commercial nut; leave the pin long enough to take a brass bearing $\frac{1}{8}$ in. wide, which will be attached to the drive rod for the mechanical lubricator.

The gland nut can be made either from a casting, or from $\frac{5}{8}$ in. round bronze or gunmetal rod, a piece full $\frac{1}{2}$ in. long being needed. Chuck in three-jaw, face the end, centre, drill right through with 17/64-in. drill, open out to $\frac{5}{8}$ in. depth with letter "R" or 11/32-in. drill, and tap $\frac{5}{8}$ in. × 32. The threads shouldn't be too easy, or the gland will slack off when the engine is running fast. Chamfer both ends, and cut four or six C-spanner grooves along the nut. Anybody who hasn't a shaper, or milling-machine, or any other facility for groove-cutting, can do the job in the lathe by screwing the nut on the end of a bit of rod threaded to suit, and holding the rod in the chuck. Put a parting-tool in the slide-rest tool-holder, on its side, setting the edge at centre-height. Feed it in with the cross-slide, and traverse it along the nut with the top-slide. It will then cut a nobby groove. I specified $\frac{5}{8}$-in. material for the nut, so as to enable fairly deep grooves to be cut, but anyone who so desires, can reduce the

(*Continued on page* 354)

A "Dundee Bogie"

Caledonian Railv



UP to the war years, all my model making was confined to marine work, as there was a good sailing pond just round the corner. However, after the war I removed to another part of Scotland and as there is no decent sailing water for miles, the boats had to go, and a complete change to model locomotives was made.

The idea of building a 4-4-0 Caley came from a small illustration in Jamieson's *Steam Engines*, of 1896, which I happened to pick up in the local library. A visit to the Royal Scottish Museum and the Glasgow Art Galleries yielded quite an amount of detail about the engines of the period, due to the kind co-operation of the curators of the engineering departments.

Official Drawings

After some correspondence with various engineering firms, a sectional general arrangement of the engine and tender was obtained from the British Railways' works at St. Rollox, Glasgow. These drawings were 1 in. to 1 ft. photostat copies of the original drawings of 1876, and are a magnificent example of the draughtsman's art.

They are really five sections superimposed on one another, and after close study one could find all the detail necessary.

It was decided to go the "whole hog" and make the engine 5-in. gauge. The frames are cut from $\frac{1}{8}$-in. mild-steel with four cross-stays of the same material and buffer beams of $1\frac{1}{4}$-in. × $1\frac{1}{4}$-in. × $\frac{1}{8}$-in. angle all riveted with $\frac{3}{8}$-in. × $\frac{3}{8}$-in. $\frac{1}{16}$-in. angles on each side. The buffers are mounted on a $1\frac{1}{4}$-in. × $\frac{1}{8}$-in. plate with an oak spring between it and the beams.

The hornblocks, bogie pivot and bogie stretcher were all cast at home from scrap gunmetal of all vintages. They have proved very successful, although at the time, various wangles had to be resorted to in order to work up sufficient temperature to ensure a good casting. All the axleboxes were cut from a stick of $1\frac{1}{4}$ in. × $1\frac{1}{4}$ in. bronze unearthed in the local scrapyard.

Springing Arrangements

The springs are laminated, eight having eleven leaves and four seventeen leaves. The main leaves are strips cut from an annealed power hacksaw blade which had outlived its cutting days, and the intermediate leaves are out of a gramophone spring which was guillotined up the centre.

Wheel and cylinder castings were a problem, as no stock castings could be obtained with rectangular spokes; so finally, patterns were made for the whole lot, and these were very kindly cast by a local firm of agricultural implement manufacturers, who, incidentally, refused all payment—wha' says, Scots are mean?—They were a lovely job and machined beautifully. The axles and crankpins were all machined from mild-steel bar.

The valve-gear assembly is of the Gooch type and all parts are case-hardened. The eccentrics are steel and the straps are fitted with renewable bronze liners. The cylinders, as already mentioned, are cast-iron with cast-iron pistons each with two rings. The valve and piston-rods and valves are stainless-steel.

An axle driven pump and an "L.B.S.C." lubricator are fitted; but, by judicious wangling, they are not seen from outside the engine. A dummy lubricator was fitted on the funnel.

The boiler is of copper, riveted and silver-soldered throughout. When on test, an enthusiastic helper on the pump ran her up to 300 lb. per sq. in., but fortunately she took it all and no damage was done. The working pressure is 90 lb. per sq. in. All clack valves and boiler mountings are of "L.B.S.C." design modified in outward appearance to suit the engine.

The superstructure is entirely of brass, 16- and 20-s.w.g., silver-soldered at all joints except for the cab and running-board angles which are riveted on. The two sides are made as units which sit in place

vay Loco. No. 128 in 5-in. Gauge

By William G. Small, M.Coll.H.

and are held by a screw, fore and aft. When in place, the cab roof and front are attached by six screws. Incidentally, by this method and by unscrewing half a dozen pipe unions, it is possible to lift the superstructure and boiler in about 10 min. and leave the chassis open for any servicing which is necessary.

The smokebox is bent up from $\frac{1}{8}$-in. brass plate and silver-soldered. The funnel is also made from sheet brass with a half-round bead at the top and a base cut out of a tail end of brass bar. The dome was worked up from a piece of 26-gauge copper with a $\frac{1}{16}$-in. half round bead at the bottom edge. The pressure gauge was made after seeing an article in THE MODEL ENGINEER. After several disastrous attempts, a successful Bourdon tube was produced and works very satisfactorily.

The tender was made from 16-s.w.g. brass mounted on a $\frac{1}{8}$-in. steel chassis; it is fitted with working brakes operated by a hand-wheel on the footplate. The low running-board and handrail are of interest as apparently the fireman had to go out with a hose and put out the fires on the wooden blocks when they were coming down the bank from Gleneagles to Stirling or to Perth.

When all painted in her " Caley blue " with maroon framing and cream and black lining she looks quite presentable. With her big drivers she has a good turn of speed, although she will never be a heavy load puller. In this she is true to type as I believe the originals were used on express passenger services with small light rolling stock.

The originals took the road in 1877 and the last one I can find record of was at Stirling in 1920, when the last of the " clan " was used as a banking engine on the run up to Kinbuck for the Perth trains.

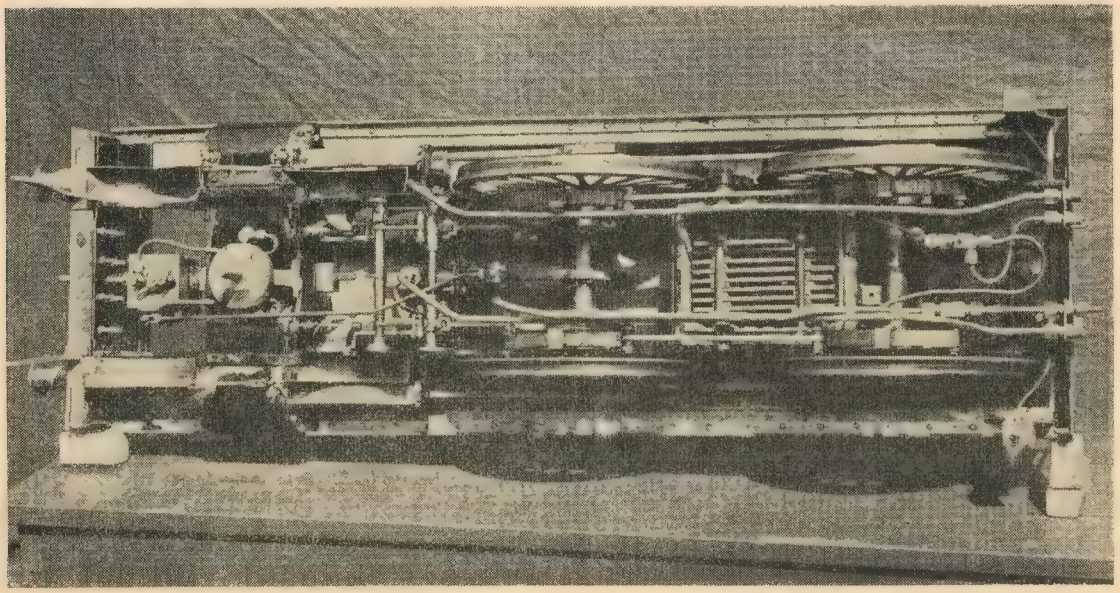
Criticism Invited

As this is a first attempt, I should be interested to hear from any experienced builders—their criticism—which is always of help to a person branching out in a new sphere. The building has been spread over four years, and has provided many pleasant hours at the lathe and bench. The next one for the fleet is to be a 5-in. gauge version of *Tich* as the youngsters demand a " Pug " for their own use.

For the coming summer, running will be confined to a club track in the district, but by next summer it is hoped to have a 50 ft. circle in the garden, as it is no picnic humping 1 cwt of locomotive over the landscape !

Since the above was written I have had several outings; the most successful was at the opening of the Ardeer track where the engine did eight laps at a speed of 8-9 miles per hour. I was the only passenger and her water consumption was a pint for the 1,200 odd yards with only a handful of coal. I also entered the engine for the Scottish " Model Engineer " Exhibition at Glasgow, and I was both surprised and pleased to find that I had been awarded the North British Locomotive Co's. Challenge Cup in the locomotive section.

The two photographs were taken by A. J. Atkinson, B.Sc.



A view from underneath, showing the full detail of the 5-in. gauge Caledonian Rly. locomotive

IN THE WORKSHOP
BY DUPLEX.

Constructing an Engraving Machine

ALTHOUGH letter and figure hand-stamps serve many useful purposes in the small workshop, these simple tools can hardly be expected to form the lettering on name-plates, for example, up to the standard readily obtained with an engraving machine.

Inscribing metal and plastic material, forming parts of instrument and electrical work, with lettering and figures is also a problem when only hand-tools are available, but an engraving machine will do this, and a great deal more, with neatness and precision. Light die-sinking can also be carried out in the machine, so that moulds can be cut out for casting name- and number-plates with raised lettering. Again, realistic tread-plates, with raised ribbing, can be cast in light alloy in moulds easily and accurately cut in the machine.

In addition to incising letters and figures, the engraving machine can be used to cut out contours in sheet metal.

Since the machine was built, a variety of work, not thought of at the time, has been undertaken; this includes engraving the dogs' collars, and making a set of name-plates for the stops of the organ in the village church.

The standard type of commercial engraving machine is, however, expensive and may, we understand, even cost some hundreds of pounds, but the machine here described was built entirely from materials and parts drawn from the workshop store boxes, and no additional outlay was needed. There is, too, no real difficutly in building a machine of this kind and, apart from the straightforward main assemblies, all that has to be added is a system of linkages, made to the dimensions given in the working drawings. The machine consists essentially of a guided tracing style and a motor-driven cutter head, both of which are mounted on a pivoted pantograph frame. The actual work-piece is clamped to a table, and this table, together with the pantograph, is secured to a column fixed to the base of the machine.

For the tracing plate or guide for the style, a Uno stencil has been found to give satisfactory working. In commercial practice engraved metal copy plates are used for guiding the style and, if this method of working is preferred, there is no reason why a set of these plates should not be made in the finished machine itself.

One advantage of using copy plates is that the type can be set up as in a printing machine, and there is then no need to move the stencil to and fro in order to bring the required letters into position.

The Machine Column and Work Table

The components illustrated in Fig. 2 formed part of a drilling machine, but their exact proportions are unimportant, provided that the structure is reasonably rigid and will stand firmly. However, machined castings suitable for this purpose are supplied by Messrs. E. W. Cowell, whose advertisements appear regularly in this journal.

In the photograph of the finished machine, it will be seen that a

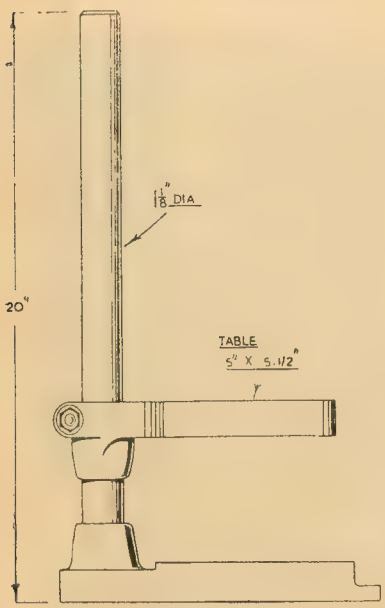


Fig. 2. The column, table, and base assembly

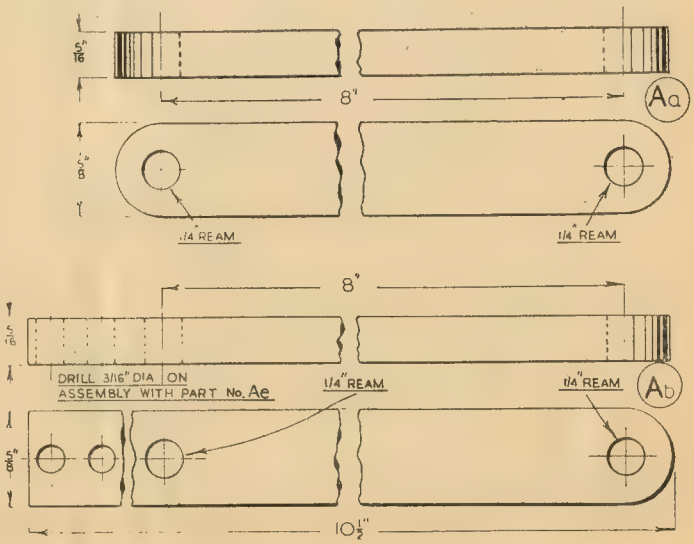


Fig. 3. The two long pantograph arms

disused slide-rest is secured to the table in order to facilitate aligning the work and spacing the lines of engraved lettering. But this refinement is by no means essential, and satisfactory working can be obtained by fitting the table with adjustable guide strips; if these guides are graduated, there will be no difficulty in setting the between-line spacing, or in maintaining a uniform width of margin.

The Pantograph A

There is no need, here, to go into the geometrical construction of a pantograph, and it is enough to say that the frame must be a true parallelogram with accurately-fitted, free-moving joints at the four corners. The ratio between the size of the guide letters and those actually engraved can be varied at will, by altering the position of both the pivoting point on the machine column and the point of attachment of the cutter head; as will be described later, the pantograph arms can be graduated in order to facilitate making these adjustments. The four limbs of the pantograph are made in two pairs, from $\frac{5}{16}$ in. × $\frac{5}{8}$ in. mild-steel. One pair, *Aa* and *Ab*, is 8 in. between centres, and the other, *Ac* and *Ad*, 6 in. between centres, but as shown in Fig. 3, one of the former parts has an extension for attaching the arm carrying the style. To ensure uniformity, the limbs should be drilled and reamed when clamped together in pairs. It will be clear that, for the smooth and accurate working of the machine, the pivot joints at the four corners of the frame must move with but very little friction and be free from backlash.

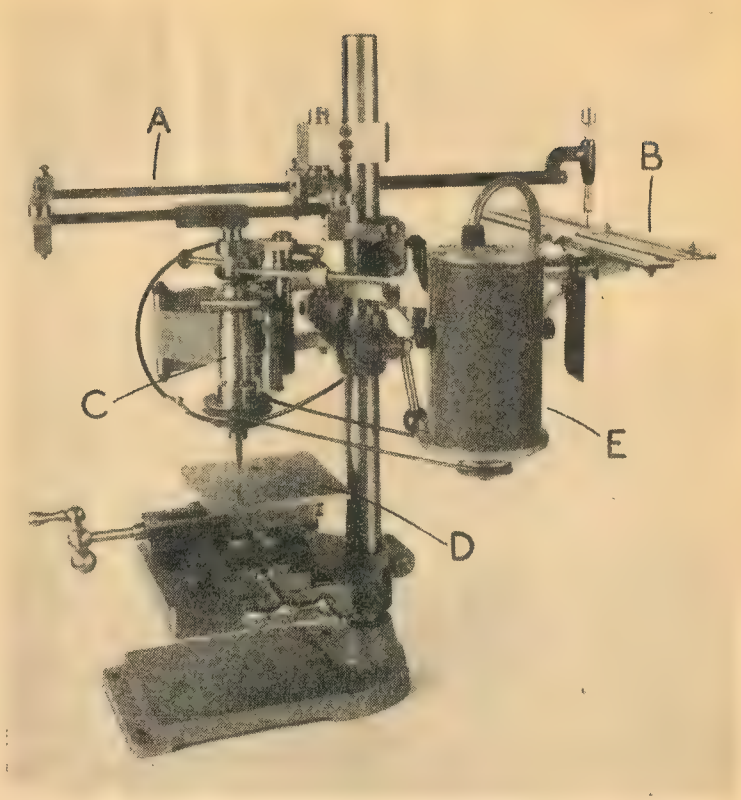


Fig. 1. The finished machine. A—the pantograph; B—the tracing table; C—the cutter head; D—the work table; E—the driving motor

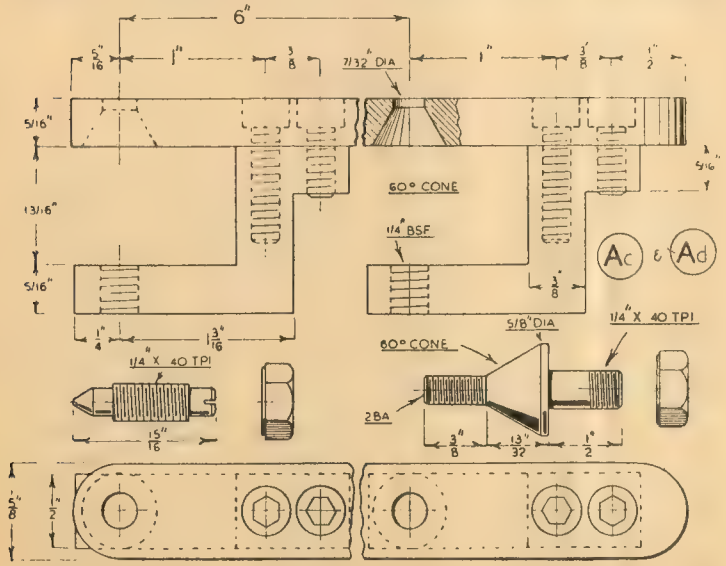


Fig. 4. Showing the two short pantograph arms and details of the pivot joints

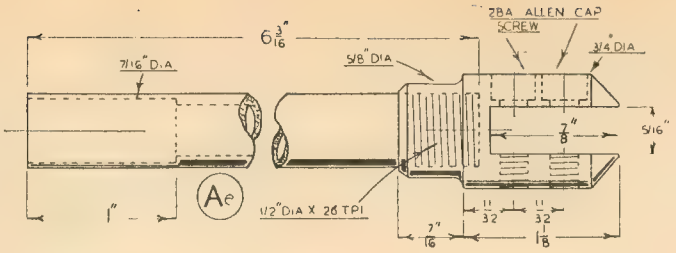
In the method of pivoting illustrated in Fig. 4, the coned spindle rides in a coned seating formed in the upper limb of the frame, and the lower limb is secured to the spindle with a nut. The lower bearing for the spindle consists of an adjustable, coned centre, engaging in a coned seating drilled in the end of the spindle. To prevent wear and to afford smooth working, it is advisable to harden or case-harden both the spindle and the adjusting-screw; in addition, the bearing surfaces should be polished with a fine abrasive.

With the pivoting carried out in this way, it was found that the pantograph assembly was amply rigid and free from shake, but at the same time movement was quite free. It will be noticed that the upper end of the spindle is shown threaded so that, if needed, a nut and washer can be added to protect the bearing.

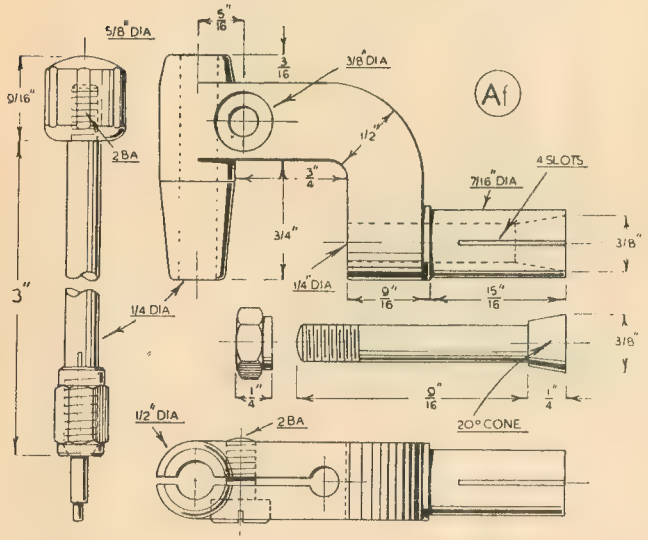
The Tracing Arm Ae

The inner end of this tubular arm is attached to the pantograph frame with two Allen cap-screws and, at its outer end, the arm carries the

(*Right*) *Fig. 5. The tracing arm*



(*Below*) *Fig. 6. Details of the tracing head and stylus assembly*



tracing head. This head, *Af*, is secured to the arm by means of an expander-bolt, so that it can be set exactly vertically on assembly. The style itself is carried in the vertical bearing housing in the head; this bearing is split, and fitted with a closing-screw, to provide frictional control for the style while being engaged in its guide plate.

It makes a great deal of difference to the smooth working of a mechanism of this kind if the two mating parts are lightly lapped to remove any surface irregularities. The guide pin fitted to the stylus spindle is best made of silver-steel and then hardened, as it is subjected to wear. As shown in the drawing, this pin is mounted in the recessed and slotted end of the spindle, where it is held in place by means of a knurled closing-nut. This enables the guide-pin to be changed, as required, to suit the size and form of the figures of the stencil or guide plate used for tracing.

(*To be continued*)

L.B.S.C.'s "NETTA" IN FIVE GAUGES

(*Continued from page* 349)

diameter to ½ in. Alternatively, make the nut from ½-in. hexagon bronze, either cast or drawn. Finish the hole for the ram with 9/32-in. reamer. If a casting isn't available for the pump body, the valve-box can be made from ⅜-in. round rod, machined as described for the casting. Drill a 7/32-in. hole in the side, in the centre of its length. Turn the pump barrel from ⅜ in. round rod, and turn a spigot on the end, to a tight fit in the hole in the valve-box; silver-solder the joint.

The pump barrel is screwed through the tapped hole in the pump stay, and erected as mentioned previously for the frame stays; the location is shown in the frame drawing. Details of the eccentric-strap and rod were given in the drawing of the pump assembled, in the last instalment; the rod is filed up from 3/32-in. steel. Tip : you'll probably find it far easier to mark off the outline of the rod on a piece of steel sheet, sawing and filing to shape, than to try and bend up the rod from strip steel. The strap is machined up from a casting; just clean the outside with a file, drill the ears No. 48, and saw across, using vice top as guide. Tap the holes in the lug half, either 3/32 in. or 7 B.A., open out the holes in the other half with No. 41 drill, and screw the halves together, smoothing the contact faces if they are sawmarked. Chuck in four-jaw with the core-hole running as true as possible, face one side, and bore to fit nicely on the pump eccentric. To face the other side, either put the strap on a stub mandrel held in three-jaw, or mount on the smallest step of the inside jaws of the chuck, if they will close in small enough. I fitted a baby chuck to my Boley lathe, especially for jobs like these, and it is a time-saver.

The lug can be slotted by making a sawcut and finishing with a thin file, if no machining facilities are available; and the rod is riveted into the slot by two 1/16-in. rivets. It can be soldered as well, for extra safety. When the eccentric is on front centre, in the position shown in the previous drawing, the ram should clear the end of the barrel by 1/32 in. Next, the larger pumps.

MORE UTILITY STEAM ENGINES

A Double Tangye Type Mill Engine

By Edgar T. Westbury

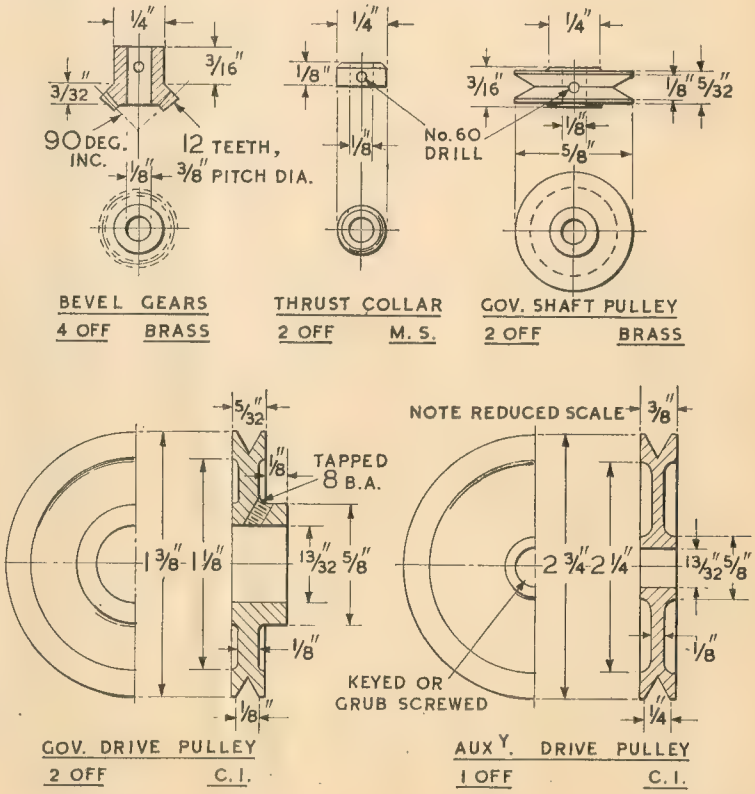
AS I have not been able to find a reliable supply of ready-made bevel gears of exactly the same size as those specified for Mr. Ballantyne's engine, I propose to use the same size gears as those of the "Unicorn" engine, which are a little smaller, but quite adequate for the job they have to perform. As already mentioned, these can be obtained from Bond's o' Euston Road, and are the only ones available of anything like the right type and size, so far as I can ascertain. It may be necessary to adjust the length of the bosses by skimming the back faces, to get them to mesh sweetly, by mounting them on a pin mandrel, as described for the previous engine, and when properly adjusted, it is advisable to pin them to their shafts in preference to relying on the grub-screw for permanent location.

If constructors have bevel gears available which will fit into the available space, they can of course be utilised; there are an enormous number of small gears of all kinds still obtainable on the surplus market, and it is not absolutely necessary to stick to "mitre" gears of 1 : 1 ratio. It is, however, essential to use gears which are properly paired in respect of pitch angle, that is to say, one cannot mesh a bevel gear of 90 deg. included angle with one of 60 deg., for instance. The smaller of the two gears (if any) should be fitted to the vertical shaft.

No details of the shafts are shown in the drawings, as they are simply pieces of ⅜-in. steel rod cut to length as required and faced off neatly at the ends. Either mild or silver-steel may be used; the latter, though stiffer and harder on the working surface, is more difficult to drill and broach out for fitting the cross-pins which fix the gears and other components. I have already mentioned that small brads or panel pins may be used for cross-pins, being fitted by filing in the lathe; as the normal chuck will not grip them, use a small pin-chuck or drill chuck, suitably mounted, for the purpose. The heads of the pins will, of course, have to be cut off to enable them to be held in this way, and it will be advisable to steady them with a finger under the projecting end, while shaping the taper with a dead smooth file.

It will be noted that a plain thrust collar is shown fitted to the vertical shaft; this is not in accordance with the drawings of Mr. Ballantyne's engine, where the shaft presumably rests in the bottom of a blind hole, but I considered it better to provide an adequate surface to take the thrust, though it will not be very heavy, and is in fact mainly in the other direction. A light flexible compression spring should be fitted between the yokes of the vertical shaft.

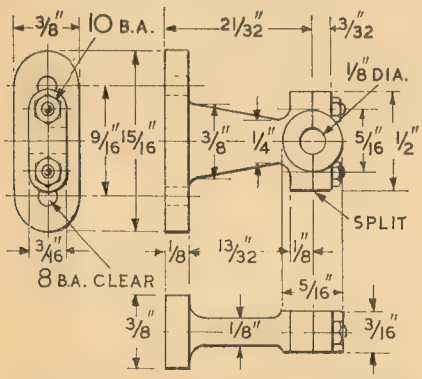
In the case of the pulley on the horizontal shaft, it is advisable to drill the cross-hole, or at any rate start it, before the vee-groove is turned to full depth, as it will be difficult to start the drill afterwards in the acute angle of the pulley. Incidentally, I find that many constructors turn these pulleys at much too obtuse an angle to provide a really efficient drive; they should never be a wider angle than 60 deg. inclusive, and this applies not only to models, but also small machine tools and similar purposes, the only exception being non-driving or "jockey" pulleys, which should



Continued from page 290, March 18, 1954.

have half-round grooves to reduce contact friction.

The horizontal shaft shown in the close-up of the governor gear of Mr. G. W. Cooper's engine (page 233, March 4th issue) has only a single bearing, the pulley being fitted on the overhanging end of the shaft, instead of between two bearings, as specified in my drawings. The latter may not be quite so simple to fit, but provide more adequate support to the shaft, especially in view of the side pull of the driving belt. Holes are provided for lubricating the bearings of this shaft, but they are of no advantage for the vertical shaft, unless lead-in elbow pipes are fitted; it will be simpler, and quite adequate, to file small grooves, inclined slightly inwards, on the top face of both top and bottom bearings, to lead in the oil. The governor components may now be fully assembled, and should run freely without harshness and tight spots; this applies to all the working joints, including the shaft and forks of the control levers.



VALVE ROD GUIDE 2 OFF BRONZE

The pulleys shown on this group detail drawing call for little comment, as they are straightforward jobs, which need only normal care in machining and fitting; it is advisable to machine them all over. The governor drive pulleys are grub-screwed to the crankshaft, and should line up with the pulleys on the governor shaft when hard up against the eccentric sheaves in each case; if not, some slight endwise adjustment may be called for. No projection of the grub-screws should be allowed. The auxiliary drive pulley is an optional fitting, which may or may not be found necessary, according to the purpose to which the engine is to be put. It may be fitted either side of the flywheel, the other side being equipped with a spur gear pinion, as in Mr. Ballantyne's engine, if there is anything which calls for such a drive, as, for instance, a geared feed pump. Alternatively, an eccentric sheave for a direct-driven feed pump could be fitted here; the type of pump employed on the "Unicorn" engine could be adapted by modifying the method of mounting, and also increasing the bore and stroke.

Valve-Rod Guide

This item is more conspicuous by its absence than otherwise on model steam engines, being somewhat tricky to line up properly; but it is fitted to most full-size engines, as it serves the purpose of taking side thrust on the rod, which would otherwise come on the steamchest gland. It will be seen that Mr. G. W. Cooper's engine lacks this provision, and thus it might be regarded as an optional fitting; but I recommend that if it is omitted, the knuckle joint should be relocated, by shortening the valve-rod and lengthening the eccentric-rod to the same extent, so as to reduce the overhang of the rod outside the gland.

Mr. Ballantyne went so far as to fit split bushes to the valve-rod guide, which is no doubt correct practice, but hardly necessary in the model from the practical aspect; however, constructors can please themselves on this point. The main essential in machining the casting is to ensure true parallel and axial alignment of the guide bore with that of the gland; dimensions will be influenced by the provision made for attaching the guide base to the engine structure, which will be considered presently. While it is not absolutely necessary to split the guide bearing, it is very desirable, as it facilitates assembly and dismantling of the valve-gear components. A careful check of measurements should be made before machining the base and the surface of the split bearing, to ensure that the latter comes exactly on the centre-line of the rod, with due allowance for any packing which may be inserted between the steamchest and cylinder surfaces. One way of gauging the position of the slide-rod guide bearing would be to turn up a gauge-pin with an exactly concentric point, to fit tightly in the steamchest gland, projecting far enough to enable it to be used as a scriber point against the boss of the guide casting. After machining to this line, and fitting the cap of the bearing, the casting may be mounted on a small angle plate for centre-drilling, drilling and reaming the bore.

Governor and Slide-rod Guide Mounting

As the governor assembly, and also the slide-rod guide, have to be mounted on the trunk standard, it is rather remarkable that in none of the castings or finished examples of these models that I have seen, does there appear to be any provision for accurate location of these components. The need is, of course, the more urgent in the case of the slide-rod guide, but good engineering practice would, I am sure, insist on the need for facings on the trunk casting which could be machined or otherwise trued up to locate both units firmly and securely. It is possible to produce facings by undercutting the rounded surface, or alternatively, to use concave saddles on the attached parts, but neither can be regarded as really sound practice. I have, therefore, asked Messrs. A. J. Reeves, who are supplying the castings for this engine, to modify the patterns by the addition of facings, as shown in the accompanying part views These are only very slightly raised above the rounded surface, but provide the necessary flat seatings, which can be either filed or machined truly horizontal and vertical respectively, and parallel with the trunk axis in each case. The tapped holes can be spotted from the attached components when their location has been determined; this is not critical in the case of the governor frame, but the valve-rod guide should be aligned by inserting the valve-rod, or a dead straight test-rod, through both the guide and the steamchest gland, and making certain that it will slide freely when the former is clamped down.

If the centre of the axis does not exactly coincide in both parts when fixed, the foot of the guide casting may be either skimmed up, or filed and scraped, as may be necessary to correct alignment; but it is obviously better if neither of these expedients is called for.

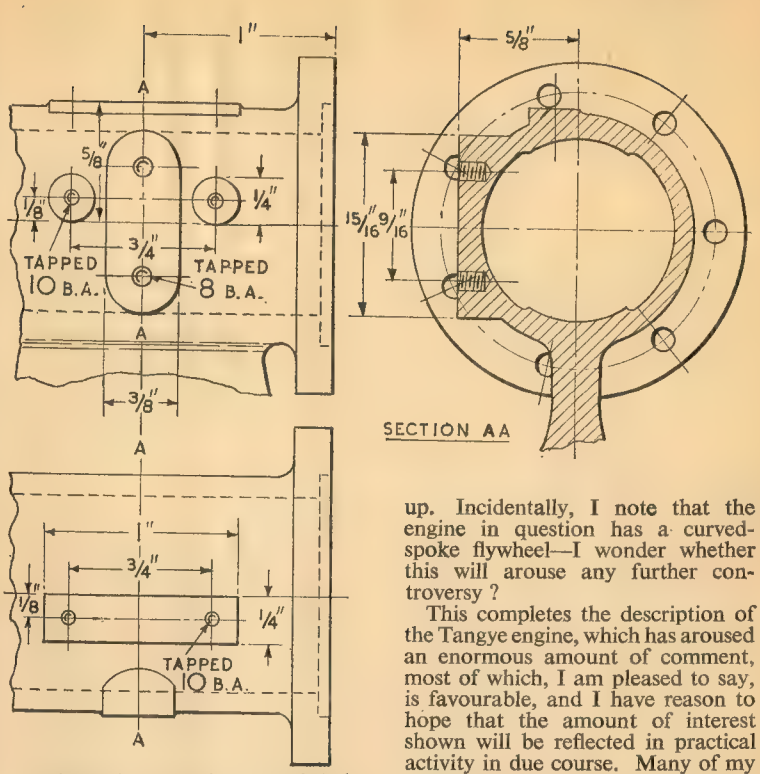
Assembly

This should be plain sailing if the component parts have all been accurately machined according to the methods described. I have already given instructions on the lining up of the main shaft bearings, but it may be found desirable to do a little scraping on the brasses to get them to bed down perfectly.

Oil cups, as described for the " Unicorn " engine, should be fitted to the bearing caps, and these can be obtained ready-made in a suitable size—but it is much more fun to make them ! The location adjustment of the pistons and other working parts has also been dealt with.

Valve setting follows exactly the same rules as those given for the " Unicorn," namely, first adjust the valve location so that the port openings are symmetrical for either end of the eccentric throw, and then set the eccentric straps so as to give the merest perceptible amount of steam opening when the crank is at top dead centre; the two sides of the engine must of course be treated separately. As the amount of steam lap on the slide-valve is greater than that of the " Unicorn " engine, the angle of advance on the eccentric will be greater, and the cut-off earlier, resulting in more economical expansive working; but it is not necessary to worry about these details so far as getting the engine to run is concerned. They will look after themselves if the setting is carried out in the somewhat unscientific, but quite practical manner described. I do, however, urge beginners to take every possible opportunity of observing and checking up all phases of slide-valve action, as there is more in it, even on the simplest engine, than meets the eye. Many constructors indulge in complicated valve-gears which " do everything except take the dog for a walk," before having mastered the simple type—and get pretty thoroughly flummoxed over valve setting problems as a result !

It often happens that in the erection of an engine in which the parts have all been machined according to the blueprint, or the published drawings in THE MODEL ENGINEER, some of the parts do not go together with drill-book precision, and may call for something more than a scrape of the surfaces or removal of burrs. This, however, is nothing to get hot under the collar about, though some of my readers (who have apparently been brought up on mass production) have shown signs of alarm and despondency over it. In all engineering shops where engines or other machines are built " one-off," without the use of elaborate jigs or limit gauges, it is accepted practice to adjust things to fit. If a bush is ten thou. too long, or a shaft half a thou. too large, you skim it off or lap it down—and no hard feelings against the drawing office or machine shop ! I have worked on the erection of large



engines where nearly as much lathework had to be done by the fitters as the turners, and though this is by no means an ideal state of affairs, it is often more or less inevitable. Some of my readers, as I am well aware, will go to the trouble of making jigs, trammels and gauges galore before they start on a construction job—good luck to them !—but the majority have neither the time nor the inclination to do this, and will, I feel sure, be quite prepared to adopt obvious remedies for resulting discrepancies.

Single-cylinder Tangye Engines

As I have already pointed out, the single-cylinder version of this design calls for no alteration of any of the individual components except the bedplate. I have not, up to the present, prepared any drawings for a suitable bedplate, as most of my correspondents have expressed preference for the double engine; but I will do so if there appears to be a popular demand. It will be observed that Mr. Cooper's engine illustrated on page 233 has the bedplate stepped down to clear the flywheel, and an A-bracket is fitted to support the outboard bearing. Personally, I would prefer a gapped bedplate, to use the same bearing standard as the double, and thus simplify lining up. Incidentally, I note that the engine in question has a curved-spoke flywheel—I wonder whether this will arouse any further controversy ?

This completes the description of the Tangye engine, which has aroused an enormous amount of comment, most of which, I am pleased to say, is favourable, and I have reason to hope that the amount of interest shown will be reflected in practical activity in due course. Many of my correspondents have stressed the importance of following up engine designs with descriptions of suitable boilers for steaming them and I would assure them that this matter has not been forgotten or neglected.

In the first series of articles on Utility Steam Engines, I gave some examples of simple boiler designs, and since then I have experimented with three more types, intended mainly for moderate steaming rates and adequate steam and water reserve, as would be suitable for bench testing or continuous running of stationary engines. These designs have yet to be committed to paper in a finished form, but I would appreciate the views of readers as to the types of boilers which they consider to be mostly in demand.

It is generally accepted that small boilers cannot be built as scale models of full-sized types, except purely in superficial appearance, and not always that, if they are to work successfully. Most of the possibilities in small boiler design have been pretty well explored, and my own contributions in this respect have been undertaken mainly with a view to simplifying constructional methods without detracting from steam-generating efficiency.

(To be continued)

MUSICAL MECHANISM

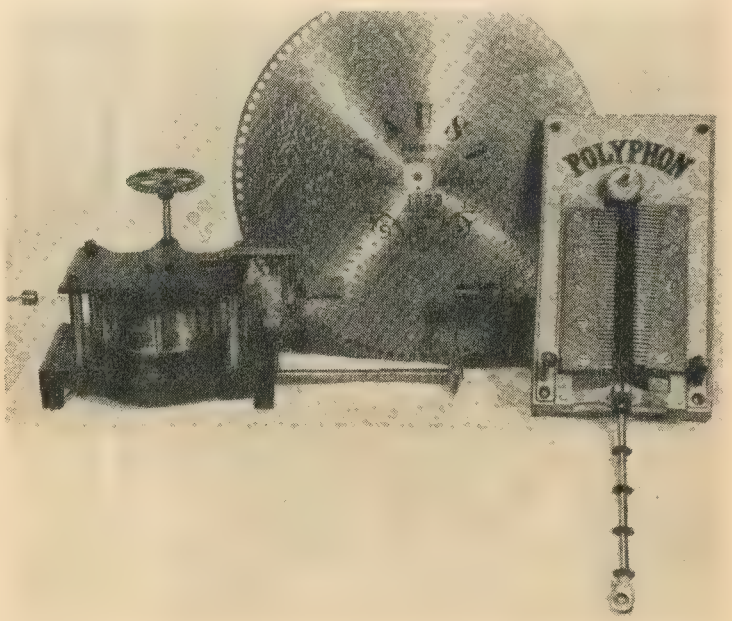
THE RECONSTRUCTION OF AN OLD POLYPHON

By "Aeolus"

THE music-playing sub-assembly was removed from the cabinet and laid on the bench Then the combs were carefully removed, the central spigot taken off and the star wheels dismantled by drawing out the shaft on which they revolve. The shaft is held in place by one $\frac{1}{16}$ in. pin. Here arose the first small snag. It was felt necessary to keep the star wheels in their correct order (a niggling job, with so many to be looked over and touched up) because of a difference in wear as between those at the bass end and those at the treble end of the scale. This difference is due to the fact that the bass tuned teeth are much stiffer and heavier than the treble ones. Some of the star wheels had been "bashed" and had lost one or more of their teeth (these totalled 8) and some were bent. It was proposed to copy good star wheels and thus produce replacements for the broken ones and to straighten the bent ones. Of 16 bent star wheels, only 7 were salved, leaving 17 to be replaced. Having no suitable equipment for machining such profiles, the new ones had to be made in a filing jig—in three batches of seven, thus leaving 4 surplus. The method adopted was as follows. Steel blanks were turned up on the lathe to full outer diameter and correct thickness and were bored to fit the shaft. Bored because the shaft is an odd—probably a millimetre—size. The exact outer diameter of a 9-pointed star wheel in new condition was not ascertainable, therefore blanks were made a few thou. larger in o.d. than the worn star wheels. All burrs were removed and precautions taken to see that the blanks were dead flat. They cannot work unless they are. A headed and threaded mandrel was turned in M.S., the mandrel stem being a good fit in the bore of the blanks, see Fig. 2. Two of the best star wheels were selected and case-hardened. One of these was threadled on to the mandrel until it rested against the head (which is smaller than the root diameter of the star wheel teeth), then 7 blanks were threadled on, and finally, the other hardened star wheel. A specially made washer was put on, and a nut (smaller than the tooth root diameter) was screwed on to the threaded portion of the mandrel, and the nut tightened with the fingers. The extended body of the mandrel was set up on a vee-block on a surface plate, and the teeth of the two hardened star wheels brought into accurate radial relation with each other by means of a scribing block. The nut was tightened, and the relation re-checked. When correct, the head of the mandrel was held in a vice (with copper clams) and the necessary profiles filed up on the blanks, using the hardened edges of the star wheels to guide the file. Needle files of correct shape were needed to finish the job. The first batch was spoiled by trying to make the lot at one "go," and a new start had to be made, but on 7 being tried, and when the knack was acquired, there was no difficulty. The tips of the teeth on the new wheels were slightly rounded off to imitate the wear on the old ones, because had they been left sharp and therefore longer, they would have plucked the tuned teeth more fiercely than the old ones. This rounding off was done against the star wheels next to which the new ones were to operate because the amount of wear differs with location, as stated earlier. Of course, two of the extra star wheels were used to supersede the two hardened ones, and the other two replaced two old ones which did not conform to the average wear on these components.

Both jockeys had flats worn on them, so new ones were made in several different outer diameters, the variations being of the order of 0.005 in. between each pair. The reason for this was that there was no way of finding out the exact diameter required, owing to wear, and it was felt that it might be well to have various sizes to assist in final adjustments; and so it proved.

To keep the star wheels and jockeys in position and alignment, a brass block is slotted at regular intervals, and they run in these slots, see Photograph No. 5. As the star wheels and jockeys must be unrestricted (save by the brakes previously mentioned) some of these slots which had been partially closed by former ill treatment were opened



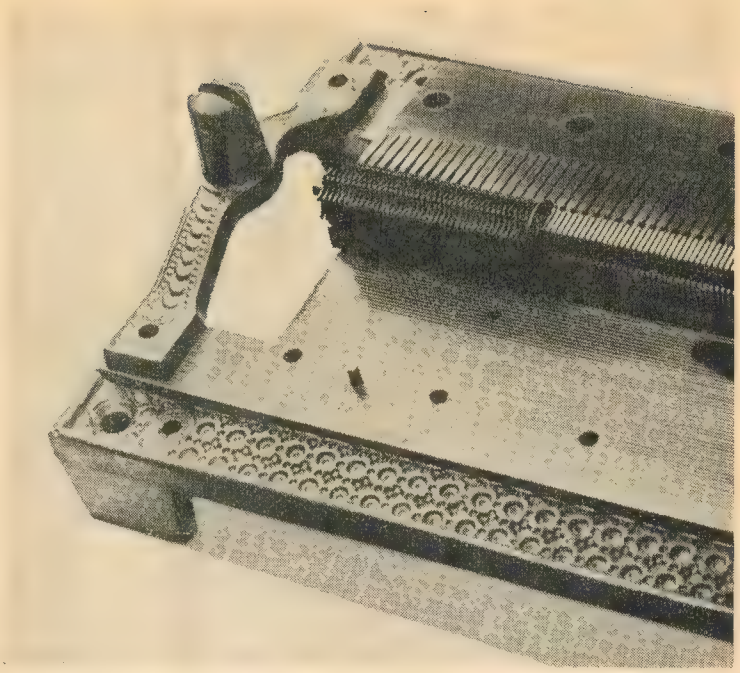
Photograph No. 4. The clockwork movement, a playing disc and the music playing sub-assembly

Continued from page 330, *March* 25, 1954.

and squared up with the blade of a screwdriver which had its edges rounded off for the purpose. A little truing with a dead smooth file was also necessary. The block, and therefore the star wheels, are adjustable by means of packing.

The tips of the tuned teeth were next taken in hand. These were distinctly worn and depressions showed where the star wheels had plucked them. It was desired to remove the high spots thus left proud because it would have been impossible to adjust the star wheels to touch the tips of the comb in exactly the same place as previously after the several adjustable components had once been disturbed. To accomplish this correction, the right hand comb, which is plucked " upwards " was firmly screwed face downwards, at the end edge of the bench, with the tips of the teeth overhanging. The wear on the extreme tips was levelled with a well oiled Arkansas stone. The bottom surface of the teeth is not square with the top, but is cut at an oblique angle; this surface showed grooves worn by the star wheel teeth, so it was also rubbed down with the Arkansas stone held as nearly as possible at the correct angle. The other comb (that plucked " downwards ") had to be treated rather differently, as in this case, the star wheel teeth impinge on the upper surfaces of the tuned teeth, cutting grooves along them, as well as indenting the tips. The tips were therefore rested on a straight-edge, with the solid part of the comb well supported (face upwards) and the tips stoned off at right-angles. Then the stone was used to smooth off the top surfaces of the teeth. Care was used to maintain the stone at an angle which would not extend its cutting beyond the wear marks left by the star wheels.

By these means, the tuned teeth were rendered no shorter than their effective length, as worn down by use over the years, because, when the stoning was finished, there was witness on each tooth, that is, one could just see, very faintly, on the tips of the teeth, the marks of the depressions left by the star wheels. To overcome the shortening of the tuned teeth, the combs, when reset, were replaced several thousandths of an inch nearer to the star wheels than formerly, In parenthesis, it may be said that even this slight

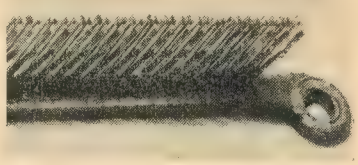


Photograph No. 5. Part of baseplate of music playing sub-assembly, with one playing comb in position, showing some of the star wheels, a jockey pulley and the slotted brass block for supporting them

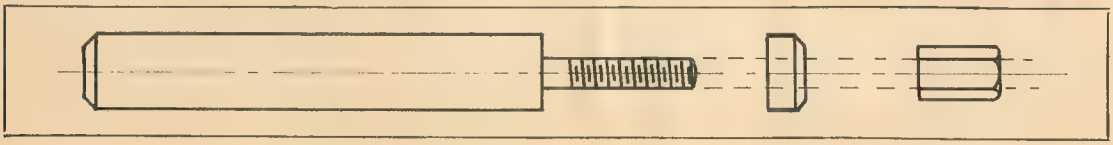
lightening of the tuned teeth by the removal of metal, must raise and slightly alter the pitch of the notes given out by them. All that can be said about this is that the alteration must be so " even " over the whole gamut of the 76 tuned teeth that there is no noticeable effect.

The dislodged resonators were then tackled. The problem was to re-solder five on one comb and two on the other, without dislodging any of the remainder. As stated before, resonators are made of lead, comb teeth of cast steel and the photographs show that the teeth are close together. If sufficient heat were to have been applied to sweat on the detached ones with ordinary solder, there would have been likelihood of unsweating more than were replaced, to say nothing of, perhaps, destroying the temper of the tuned teeth. I therefore cast round for something less liable to lead me into trouble. Wood's metal was tried in place of solder. Rather to my surprise, it worked. Wood's metal is a lead-like substance made of tin, lead and bismuth. It has a melting point between 151 and 162 deg. F., well below the boiling point of water. Using a smear of liquid flux (as used for solder) and with this metal, replacing the resonators was easy. The surfaces to be " soldered " were gently but thoroughly cleaned with a light

Right: Photograph No. 6. A few of the dampers and brakes



Below: Fig. 2. Mandrel for star wheel filing jig, in steel



brass wire brush only, the teeth of the combs alone were fluxed. The two parts were placed together with a tiny piece of Wood's metal (beaten flat) between them. They were then heated by " flashing " them with a small blue gas flame and afterwards kept hot by holding a red-hot soldering iron near them. As soon as the Wood's metal melted, the two parts were adjusted by hand against a support resting on the next adjacent resonator, and held until cool. Of course, an old glove is required ! As an experiment, this method was tried out on a discarded, useless comb before any attempt was made to repair those under discussion. In the second trial—the first was unsatisfactory—using exactly the means described above, a joint was made so good that when the resonator was purposely broken off, the lead of the resonator broke in a fresh place, not at the joint. By the way, a thin paper card inserted between a resonator refixed with Wood's metal and the next one to be treated afforded sufficient heat insulation to prevent undoing previous work.

Surprisingly, on this particular machine, the tuned teeth themselves were intact—none was broken. It is possible, in some cases, to repair broken teeth.

The next job on the combs was to try to get them back to some semblance of brightness. Removing rust from a comb is a long operation; possibly, fine emery-paper or cloth could have been used, but on the teeth, so severe a remedy was feared lest they should be put out of tune; this can be done all too easily. Worn (fine) glass and sand-paper were indeed used on the solid back part of the comb which supports the teeth, keeping the movement of the paper in one direction only. For the rest, and also to finish the uncut part of the comb, the end of a cork, dabbed in fine emery paste was used, finishing off with another cork dipped in pumice. The abrasives were washed off in " thinners " for cellulose paint. Then a meagre amount of liquid metal polish was applied. It was found that the smaller the quantity of polish used the better, because, if the rag were saturated, a white residuum settled between the comb teeth and it is difficult to clean this out of corners. The steel combs responded to plenty of rubbing. When the surfaces were good enough, a final rub given with a rag damped in " 3-in-1 " oil completed the job. Some pits caused by the rust did not wholly respond to treatment, but considering the first state of the parts, the result was quite good—better than expectations.

After refixing the resonators and cleaning the combs, it was wondered if the tuning had suffered, so, while listening, the combs were tested by plucking the tips of the tuned teeth with a finger-nail. This was rather unsatisfactory at first, for it seemed that some notes were duplicated on teeth which had not been interfered with, other than by cleaning and stoning the tips. This was probably an illusion due to an unpractised hand and ear. However, two teeth were found with refitted resonators which were definitely out of tune as between the teeth immediately above and below them. Work was commenced to get these two sets of three teeth into direct relation, so far as ear would serve. This was done by gently paring away the lead of the resonator on the tooth that was pitched at too low a tone until it sounded midway between the notes of its two adjacent teeth. In the other case, Wood's metal was added to the resonator to make too high a note just a little too deep, then this metal was pared down to make the tooth sound correctly against its two neighbours. It was soon found that a small steel plectrum was an improvement on a finger-nail; it is less liable to wear. My wife lent me her ears in the later stages. She listened while I plucked and pared. Now the results from the finished instrument leave little to be desired, so far as tuning is concerned. This dictum is not mine but has been expressed by those better qualified to judge than I.

Where dampers were missing, there was no other recourse but to make some more. Where they were distorted, they were carefully straightened to their original formation *in situ*; a few broke in the process. Replacements were slowly cut, drilled, sawn and fiddled out of spring brass of the correct gauge, " fiddled " being the operative word ! For patterns, existing examples of both types were removed from their fixings and flattened. Photograph No. 6 shows dampers (and brakes) as fitted to the right-hand comb. About a score of new ones were made. The original method of fitting was followed, and is by means of solder to supporting strips of brass, about $\frac{1}{2}$ in. wide, reducing to $\frac{1}{4}$ in. by $\frac{1}{8}$ in. thick, running the full length of the combs. They are anchored to the bed plate of the music-playing part of the machine by one cheese headed screw at, or near, each end, and are adjustable within reasonable limits. The strips are positioned one on each side of the star wheels. Packing, in the form of washers, is used by the makers for raising or lowering the supporting strips. Dampers must contact the star wheels at the correct height, otherwise they will not work properly. The method of making the necessary adjustments was by trial and error, until a setting was achieved by which all 76 worked against the tips of the tuned teeth, after the manner of a series of contact breakers as used (solo) on many types of single-cylinder i.c. engines.

The restoration of the playing discs was a long job and cannot be recounted here. Suffice it to say that most of them were redeemed from rusty near-scrap to the general appearance shown in Photographs Nos. 1 and 4.

(To be continued)

For the BOOKSHELF

Know Your Lathe. A screwcutting lathe handbook. Issued by Denford's Engineering Co. Ltd., Halifax. Price 6s., post free.

This is a well-produced and profusely illustrated instruction book intended principally for the guidance of users of the 4½-in. Boxford lathe, but practically all the information contained in it is applicable to general practice on other types of lathes. It commences with a chapter on modern change-gear lathes, followed by chapters on installing a lathe, methods of operation, lathe tools, and measuring instruments and their use. The various kinds of lathe operations are dealt with, including plain turning, taper turning, boring, screwcutting, etc. Concluding chapters deal with special types of work, attachments and accessories, and Boxford comparators and stands.

The price quoted above applies to ordinary sales to non-users of Boxford lathes, but the book is supplied at a special price, well below production cost, to present users or new buyers of this type of lathe.

READERS' LETTERS

● **Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.**

SMALL SPEED-BOAT RACING

DEAR SIR,—Some years ago, the small speed-boat of 5 c.c. and under showed signs of becoming popular; and to provide competition for these miniature boats, "D" class was introduced by the M.P.B.A. During the last year or two, however, though in one or two cases speeds of over 50 m.p.h. have been obtained, the class has almost disappeared from our regattas.

As the Bromley M.P.B.C. have the use of a pond most suitable for "D" class racing, I am anxious to find out whether there would be support for such an event at the Bromley Regatta to be held on July 4th, and I should be glad if anyone intending to enter would let me know at once. Any non-member of the club will be welcome to use our pole for a trial run on a Sunday morning by appointment.

Needless to say, in accordance with M.P.B.A. rules, effective silencers must be fitted.

Yours faithfully,

Bickley. R. H. R. CURWEN.

Phone: Imperial 1257.

MODEL WEIR PUMP

DEAR SIR,—May I second the suggestion that Mr. A. Burville be pursuaded somehow to give details of his Weir pump—I also suggest to the unwary that in using a set-up for brazing as shown on page 216 by "L.B.S.C.," that only fire bricks be used for support, builders' bricks occasionally explode under heat. As shown the bricks shouldn't get very hot, but you never quite know.

Yours faithfully,

Rothley. R. S. FARMER.

AN INTERESTING CALENDAR CLOCK

DEAR SIR,—Seeing the year clock made by H. H. Knie, in a recent issue, prompted me to send you a photograph of the "Perpetual Calendar and Musical Clock" I completed in February, 1951, at 68 years of age.

It is entirely my own design and layout, and it gives on the face:—(1) Moon's age. (2) Moon's phase. (3) Day. (4) Date. (5) Month. (6) Week number of year (small window at bottom). (7) Sun hand at this period behind the hour hand. (8) Time on 24 hr. dial with quarter minutes. (9) Moon hand to show time of its southing (when it is at the upper XII noon it will be on the meridian). (10) Musical box of eight tunes played consecutively at any time set—at the moment twice a day. (11) Electric alarm. (12) Dial highly polished, used as mirror. (13) If dial is placed pointing E. × W. the moon hand shows where the moon is in its orbit.

The brass dial is 12 in. square by $\frac{1}{16}$ in. thick, and at the back is free of all mechanism. Another plate $\frac{1}{8}$ in. thick, and spaced one inch apart, carries mechanism on both sides. The drive is from the spring barrel gear wheel to an arbor, which has a positive drive by means of an eccentric (as used on locomotive valve), and this never fails to move the pin out of the four-year cam slots, which was the most difficult operation.

All the zones I cut with fret-saw and filed. They were trimmed, and attached to dial-plate with 10-B.A. nuts.

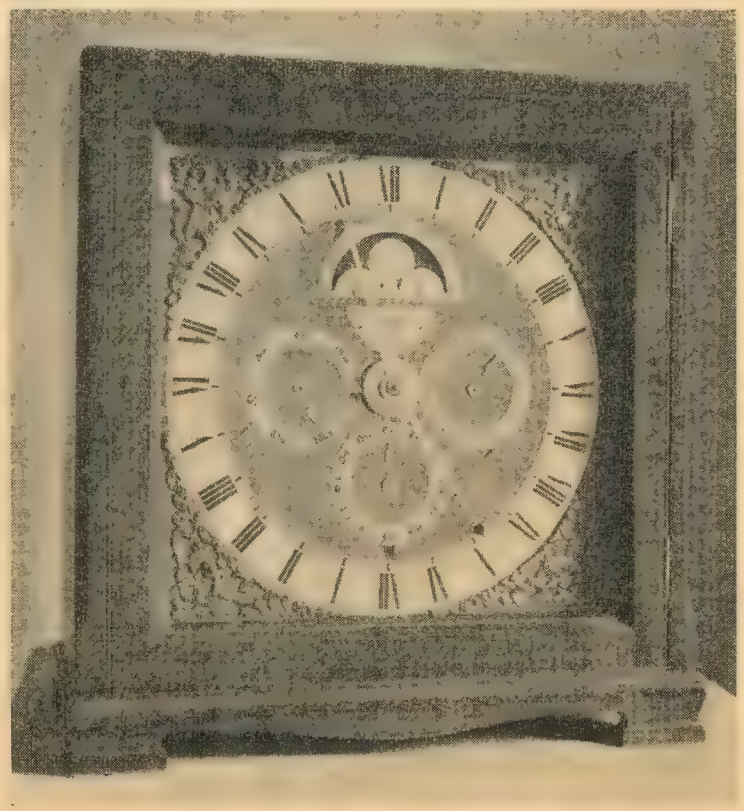
I made it of this design, as ladies do not like dusting without shifting everything. The clock may be moved about without disturbing its mechanism, as I did away with pendulum in favour of platform lever escapement.

The clock has now completed its third year of going, and had its crucial test on February 28th, when it has the most to do; viz., to advance from February on 28th to 29, 30, 31 and finally to March 1st. This it did without any trouble at all for the 3rd year.

The pin rose from the cam notch without any assistance!

Yours faithfully,

Hastings. F. K. CHALLEN.



STEEL BOILERS

DEAR SIR,—In the issue of THE MODEL ENGINEER date February 11th 1954, Mr. J. R. Burdett advocates the use of copper tubes in a steel boiler. Unfortunately slightly acidic water or water with air or other similar corrosive content would set up an electrolytic cell between the copper and steel resulting in the corrosion of the steel. The greater the proportion of copper to steel surface, the greater will be this corrosion, e.g., a copper boiler with a single steel nut in it will corrode the nut very rapidly, conversely a copper rivet in a steel boiler would have virtually no effect.

I would suggest that, unless the water supplied to the boiler is very pure, it would be better to use steel tubes which will reduce the heat transfer rate a little but not, I think, too seriously.

Yours faithfully,

Rugby. J. H. DALTRY, B.Sc., G.I.Mech.E.

DEPTH OF THREADS

DEAR SIR,—Referring to the article in THE MODEL ENGINEER dated January 21st, 1954, by "Scotia" "How to find depth of Whitworth Form Thread," whilst this information is correct, it occurred to me that some readers may ask "how to obtain constant 0.640 in.; therefore, I thought a little further information might be submitted with advantage.

The sketch herewith is of Whitworth Form thread, showing how the 0.640 in. constant is obtained. The basis being 1 thread per inch = 1 in. pitch, the angle between the flanks, measured in an axial plane is 55 deg.; one-sixth of the sharp vee is truncated at top and bottom, the thread being rounded equally at crests and roots by circular arcs tangentially with the flanks.

The formula worked to four decimal places will give the constant of 0.640 in., hence, 0.640 in. divided by number of t.p.i. gives depth of thread for Whitworth Form.

Yours faithfully,

Clitheroe. E. HARGREAVES.

L.N.W.R. STEAMCHEST

DEAR SIR,—I was very interested in the letter from Mr. Finch of Birmingham (THE MODEL ENGINEER February, 18th 1954). The design of the L.N.W. Precedent cylinders is something of a teaser to reproduce in miniature.

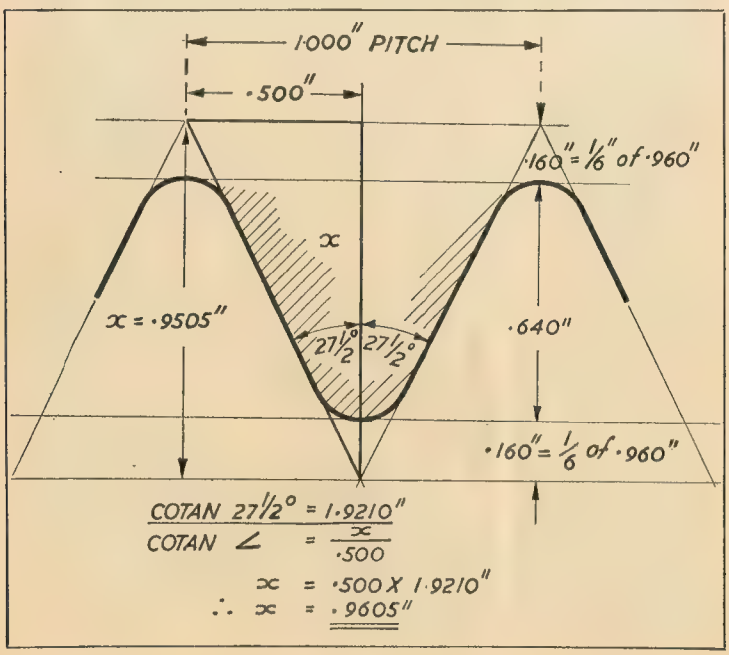
I may mention that one or two of the 2-4-2 tank engines are still left on the Rugby-Leamington services and I believe they work round to Coventry on certain trains. It appears from examination of the full size job that the front of the inclined V was closed by a triangular plate carrying the tail rod glands and bolted to the two sides of the V and to the steamchest cover. As far as I could see the back end is cast solid with the block and I don't think that in the small size there would be enough metal to take the fixing screws for a separate plate as on the front.

This raises the question of how to machine the port faces as the blind end would veto any milling or turning method. I suppose it could be done by shaping or slotting if the length of stroke was carefully set. The actual port cutting need not be difficult as a Woodruff type cutter could be set to cut R. and L. hand ports simultaneously.

I hope Mr Finch carries his job through successfully.

Yours faithfully,

Rugby. JOHN H. REYNOLDS.



IGNITION PHENOMENA

DEAR SIR,—I should like to thank Mr. Waterton and other correspondents who have offered advice and suggestions in answer to my letter which you were good enough to publish in the September 3rd, 1953 issue.

I find that I omitted to mention what is probably the most important fact—namely that the best performance of the engine is obtained when the voltage at the insulated electrode of the plugs is also negative. This is at variance with the data mentioned by Mr. Waterton as given in B.S.358, a copy of which I will most certainly obtain.

Mr. Trott's theory in favour of negative polarity for both earth and plug is, therefore, supported by the results obtained when using coil ignition; but when the magneto is in use, the earth polarity is reversed four times per revolution of the engine.

Another difference which is of interest when comparing the spark performance of multis and single cylinder engines, is that due to the action of the distributor, the polarity of the insulated plug electrode on the multi is probably at zero at all times except during the very short period of build-up and spark, whereas the plug on the single receives also a strong pulse at reversed polarity each time the contact-breaker is closed.

I would mention that the oiling arrangements of the "Seal" have now been modified by the fitting of dippers to the big-end caps on the con.-rods, and by the bevelling of the inside of the bottom edges of the piston skirts; and though this has considerably reduced the "oiling" of the engine, a recent test run with positive polarity has shown that the effect still remains.

Yours faithfully,

Bickley. R. H. R. CURWEN.

WITH THE CLUBS

The Society of Model and Experimental Engineers

The visit to the Royal Mint advertised in the Society's programme for March 4th, has been postponed by the authorities of the Mint to Friday, April 2nd, at 2.15 p.m.

Mr. Bartlett has arranged a demonstration by Messrs. Johnson and Matthey on Thursday, April 15th, at 28, Wanless Road, at 7 p.m. This will consist of a lecture, film show and demonstration. The workshop will, of course, be closed for ordinary work. This fixture does not appear in the programme.

Full particulars of the society may be obtained from the Secretary: E. C. YALDEN, M.C., 31, Longdon Wood, Keston, Kent.

Croydon Society of Model Engineers

On February 25th, at 1, Duppas Hill, Croydon, the club room was full to hear a lecture on "35-mm. Colour Slides," together with the making of the projector itself.

Those who had not done any colour work were surprised to hear that for good work, either with the camera or projector, there is no such thing as "tolerance," it must be spot on.

Hon. Secretary: R. F. WILSON, 24, Marden Crescent, Croydon, Surrey.

Leicester S.M.E.

Recent activities of the society have been an interesting visit to the Leicester Corporation pumping station, Abbey Lane, to see the fine old beam engines, used for pumping sewage, and which still serve the city so well when occasion demands, after 60 years of service, for two of the four engines are kept in steam, to take over in case of breakdown of the electric pumps, or heavy overload.

Also, a lecture on "Railway Signalling," by Mr. S. Ash, of British Railways; and films kindly loaned by British Railways.

A film night, with films loaned by the Regent Oil Co. on oil prospecting and the working of the diesel engine, and there has been an interesting mid-week visit to the works of the Leicester "Evening Mail."

There is to be a visit to Derby museum to see the "O" gauge layout of Midland Railway practice and other interesting mechanical exhibits.

Future meetings:

April 7th—Films.

April 17th—Re-opening of the running season of the track in Abbey Park.

April 21st—Further lecture on railway signalling.

It is planned to make some interesting visits to works during the summer months.

Hon. Secretary: A. E. ALLSOPP, 25, Dunster Street, Leicester.

The Blackpool S.M.E.

Our new track for 3½-in. gauge locomotives will be opened on Good Friday, April 16th, 1954, at 3 p.m. All interested in locomotives will be welcome, with or without locomotives. The track is situated in the grounds behind the Marton Working Men's Institute (on the tram-track by the Marton roundabout, and Oxford Cinema).

Our meetings are held every Wednesday night, at 7.30, at the Institute rooms.

Hon. Secretary: F. M. BRIDGE, 12, Warren Avenue North, Fleetwood, Lancs.

Ickenham & District S.M.E.

During February, a film show was given, the meeting being classed as an inter-society meeting, for members had the pleasure of welcoming their fellow-enthusiasts from the Harrow and Wembley Society and also from the Harlington Locomotive Society. Mr. J. L. Houghton very kindly showed his colour films of the making of the Harrow Society's 5-in. gauge track, from the original survey work to the official opening some two years later. It gave members a good idea of the work that lies ahead once we start building our permanent track.

A first class demonstration of the fitting of boiler stays was given by Mr. A. Haddaway, at our last meeting in February, with the aid of his mobile oxy-acetylene equipment.

Our March programme commenced on the 5th with an interesting talk given by Mr. L. Tovey about his electrode boiler.

Hon. Secretary: L. A. GROSS, 16, Thurlestone Road, Ruislip, Middlesex.

Exeter & District M.E.S.

At the annual general meeting, held recently, several reports were presented and the society completed the past year's operations with every success in every way.

The progress of the "O" gauge layout, which is nearing completion, is adequate proof of the enthusiasm which has followed its creation during the past 15 months. Members whose interests are in other sections have joined in making our railway a very excellent job and it will be amongst the best of its type in the kingdom. It will be on exhibition in Exeter in August next and is fully portable.

Working parties meet every Wednesday and Saturday evening at 7 o'clock and visitors or prospective members are welcome to call on us at our headquarters.

Future fixtures include: "Natter" night, April 3rd; lecture, April 17th, and marine section, May 1st.

Our headquarters are in St. David's Hill, Exeter, and the hon. secretary is L. M. R. HISCOCKS, 5, Prince Charles' Road, Exeter.

THE MODEL ENGINEER DIARY

April 22nd, 23rd and 24th.—Leeds Society of Model and Experimental Engineers.—Exhibition at the Corn Exchange, Leeds.

April 22nd, 23rd and 24th.—East Grinstead & District Model and Experimental Engineering Society.—Exhibition at the Sackville Canteen, De La Warre Road, East Grinstead. Open from 3-9 p.m. on April 22nd and 23rd, and from 10 a.m. to 9 p.m. on April 24th.

July 10th and 11th.—International Radio Controlled Models Society. Annual Contests for radio controlled models, to be held in Birmingham.—Model Boats on July 10th, and Model Aircraft on July 11th.

August 18th, 19th, 20th, 21st, 23rd, 24th, 25th, 26th, 27th and 28th.—THE MODEL ENGINEER Exhibition, at the New Horticultural Hall, Greycoat Street, Westminster, S.W.1. Open from 11 a.m. to 9 p.m.

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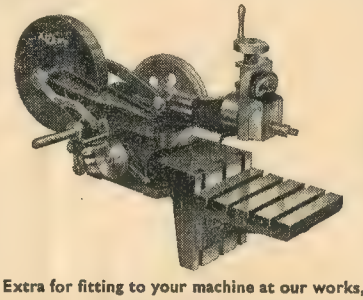

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4" Smart & Brown Bench Lathe, countershaft and motor, 15 collets, 1/16" to ½" 3- and 4-jaw chucks, lever tailstock, faceplate, T-rest, etc., as new, £75. Also horizontal miller, 8" power shaper. Evenings: Bowes Park 1937.—54, Outram Road, Wood Green, N.22.

Wanted. "Abwood" milling attachment, No. 1 size.—36, The Ridgeway, Watford.

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For Sale, about £25 of unused "M.L.7" spares and various other parts, £15. Can be seen any time after 6.30 in the evening.—"Starhaven," Brockley-Hill-Farm, Stanmore.

"M.L.7" 3½" Motorised Lathe, on cabinet stand with accessories, 230/250 a.c. single phase, £65 o.no.. View Tuesday, Wednesday, Friday evenings.—37, Cliff Road, Carlton, Notts.

2½" Voumard Precision Instrument Lathe (Swiss) offered in level exchange for Stuart Turner No. 600 gas or petrol engine or similar. Tom Senior pedestal hand shaper, 3½" Wolf-Jahn precision lathe, and Crossley 3½ h.p. horizontal petrol paraffin engine for sale or exchange. Wanted small saw bench, 200-1-50 ¼ h.p. motor, and 4½"-5" B.G.S.C. lathe, old type accepted if first class condition. Offers—EVANS, 19, Wordsworth Avenue, Roath, Cardiff.

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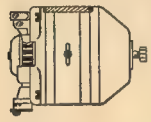

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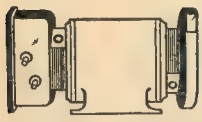

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Minilec Motor for MODELS 3-6 V d.c. 4,000 r.p.m. Size 1 x 1". Spindle 3/32 x ⅝". In makers' Cartons, New for only 7/6. P.P. 6d.

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163, EDGWARE ROAD, LONDON, W.2

Crown Wheel and Pinion for 1938 Austin Big 7. Brand new in carton, £4 10s.—Box No. 7230, MODEL ENGINEER Offices.

Wanted. Antique Firearms, revolvers, pistols, rifles, blunderbusses, gunpowder flasks, etc.—DENNIS, 28, Langley Road, Slough.

TV Without Mains, AC/DC self-starting "Chorehorse" generator. As supplied to B.B.C. A.C. mains voltage: 250/300 W., A.V.C. D.C. output available for lighting, will also run small tools, etc., £47 10s., plus 10s. delivery.—Below.

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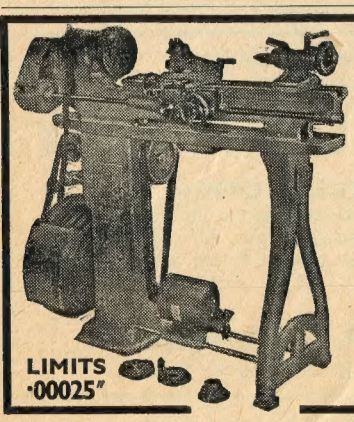

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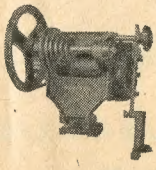

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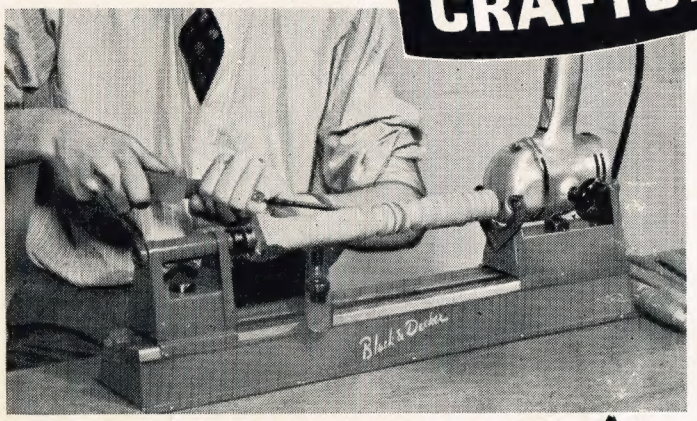

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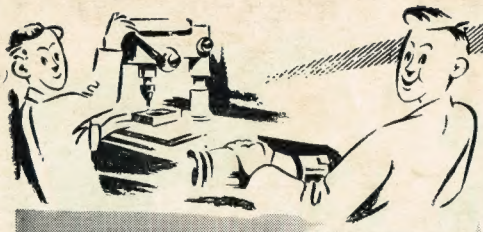

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